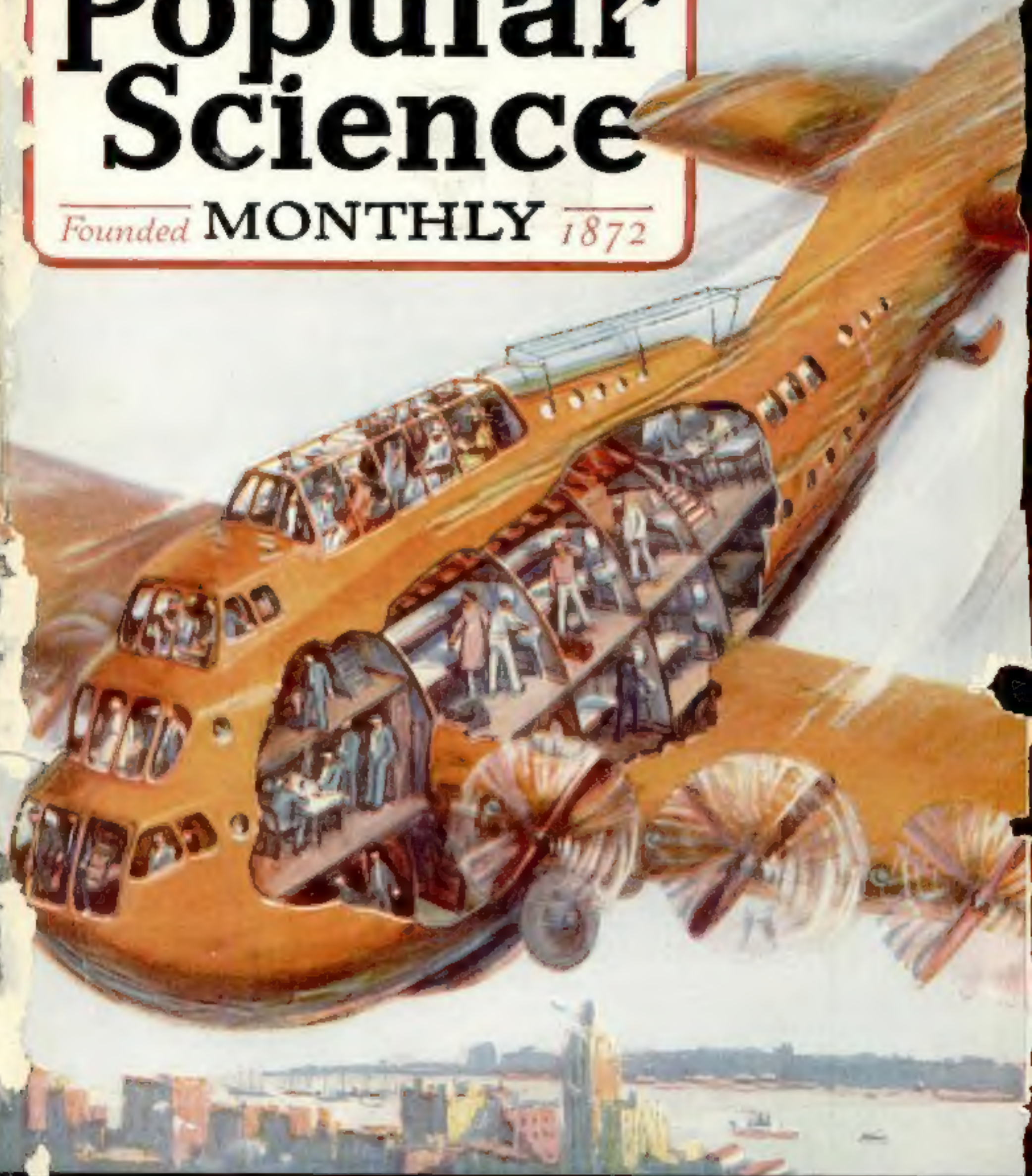


JACK BINNS' **RADIO** DEPARTMENT

Popular Science

Founded MONTHLY 1872



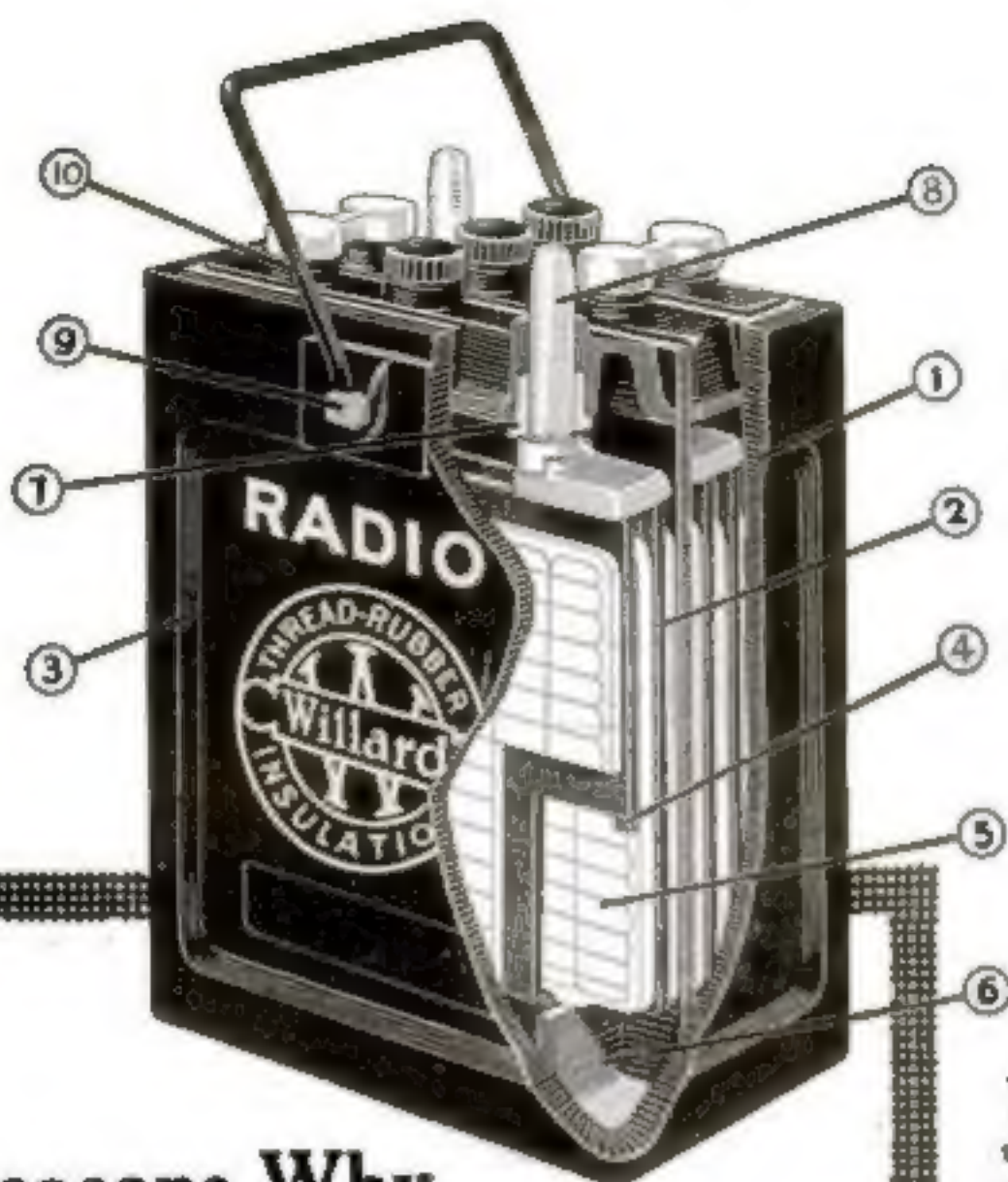
Eddie Rickenbacker Predicts Huge Passenger Airplane—(See page 35)

*In This Issue: Herbert Hoover, Henry Ford,
Glenn Curtiss, Charles P. Steinmetz*

JULY

25 CENTS

The Willard All-Rubber Radio "A" Battery (shown here) is designed especially for radio use.



Ten Reasons Why The Willard All-Rubber Radio "A" Battery is Better

These reasons, back of the success of this specially designed battery, are as definite as those responsible for the success of the Willard Threaded Rubber Battery, which is now standard original equipment on 195 makes of cars and trucks. Ask for particulars from your dealer or at the nearest Willard Battery Station.

The Willard Radio "B" Battery is a 42-volt rechargeable storage battery, with leak-proof glass jars and Threaded Rubber Insulation. Assures freedom from frying and hissing ground noises.

WILLARD STORAGE BATTERY COMPANY
Cleveland, Ohio

Made in Canada by the
Willard Storage Battery Company of Canada, Limited, Toronto, Ontario

Willard

THREADED
RUBBER
BATTERY

1 The rubber case is made in one piece, thoroughly insulating the battery from cells to ground and from cell to cell, and effectively preventing all ground noises.

2 Plates are insulated with Threaded Rubber Insulation, which by reason of its uniformity allows every part of each plate to do an equal share of work.

3 Battery is shipped in absolutely Bone-Dry condition so that it is brand new when you get it.

4 Insulators are made with special heavy ribs to meet the special requirements of the radio battery.

5 Plates are extra heavy to provide current at steady voltage for considerable periods.

6 Sediment chambers are large to eliminate all possibility of short circuits at plate bottoms.

7 Posts are sealed by soft rubber gaskets, so that solution cannot seep out between post and cover.

8 Terminal posts are high to permit easy grip of battery clamps.

9 Bram knobs sunk into the sides of the rubber case provide a firm hold for the handle.

10 Handle made of a heavy rod furnishes easy means of carrying the battery.



In every man's life there is one Big Moment when he makes the decision that either robs him of success—or leads on to fortune

Your One Chance to Earn The Biggest Money of Your Life!

HAVE you ever considered why our richest men come from our poorest boys? Isn't it a strange thing that it is almost invariably a young fellow who starts life without a cent in the world, without education, without influential friends—in short, without one single solitary advantage—who accumulates millions of dollars? Isn't it a miracle that inside of a comparatively few years a man can rise from abject poverty to fabulous wealth?

Astonishing, certainly—but more important, it is wonderfully inspiring. For it means that no man need be held down by circumstances. Once he knows the "millionaire's secret," he can put it into operation regardless of all obstacles that seem to block his path. His fancied handicaps simply vanish into thin air. He suddenly finds that everything he touches turns to gold—money flows in upon him—fortune showers him with its favors. Everything he wants seems to come to him just as surely and easily as day comes after night.

The Secret that Makes Millionaires

But millionaires are not the only ones who use this secret. It has made every great man of history. Think of Napoleon—an unknown Cornican soldier in the ranks—then suddenly startling the world with his meteor-like rise, overthrowing empires, reshaping the destinies of nations!

What is this amazing secret that can work such wonders? It is just this: *The thing behind all big achievement, whether in business, political or military life, is opportunity.* The man who wins is the man who sees his opportunity and seizes it. The man who never rises above the rut is the man who lets his opportunity pass.

To every man there comes one BIG opportunity—the golden chance of his life. And in the moment he decides for or against that opportunity—whether he will seize it or let it pass—he decides the whole future course of his life.

How often you hear a man say: "If only I had recognized my opportunity when it came—if only I had taken advantage of it—I would be a rich man today."

The world is full of such men—they plod along year after year—slaving away, hoping that somehow things will take a turn for the better. But their chance for success is gone—it lies buried in the graveyard of neglected opportunity.

On the other hand, let a man see and grasp his Big Opportunity—no matter how obscure he may be, how poor, how lacking in advantage—and his sudden rise to success will astonish the world. People will gasp at the amazing transformation in his fortunes. Read the life of any millionaire and you will find this to be so.

Choose Between Low Pay and Magnificent Earnings

This very minute you may be face to face with your Big Opportunity—your one chance to earn the biggest money of your life! Right now your decision may mean the difference between a life of plodding, routine work at low pay and a career of inspiring success and magnificent earnings.

For now you are offered the very opportunity that has made other men rich, that has brought them more money than they ever dreamed of earning.

It is the same opportunity that lifted Warren Hartle, of Chicago, out of a job in the railway mail service, where in ten years he had never gotten beyond \$1,600 a year, and landed him in a \$10,000 a year job. It jumped Charles Berry, of Winterset, Iowa, from \$60 a month as a farmhand, to \$1,000 a month. It brought to C. W. Campbell, of Greensburg, Pa., a clerk on the railroad, a position that paid him \$1,562 in thirty days.

These men and hundreds more have found their Big Opportunity in the wonderful field of Salesmanship. They are all Master Salesmen now. They are earning the biggest money of their lives—more than they ever thought possible—they are engaged in the most fascinating work in the world—they are independent, come and go as they please—they meet big men—every minute of the day is filled with thrilling variety.

Your Big Opportunity may be here too, in the wonder field of Salesmanship. Perhaps you say you have never even thought of becoming a Salesman. But before you decide one way or the other, read the facts for

yourself. See what Salesmanship offers you—why it is the best paid of all vocations—there is no limit to what you may earn. It is the amazing proof that, no matter what you are doing now, you can quickly become Master Salesman in your spare time at home—read how the National Salesmen's Training Association in its nation-wide search for men to fill the great need of Salesmen, has devised a wonderful system that reveals to you even the Secret of Selling without interfering in the least with your present work. See how this famous organization helps you to a good position in the line of Selling you are best fitted

The opportunity that the N. S. T. A. offers you may be your one chance to earn the biggest money of your life, as it has been for hundreds of others. But whatever you do, do it now—pass it by without getting the facts.

Just mail the coupon below for our free book "Modern Salesmanship." Let us tell you how the National Demonstration Method will enable you to solve almost every sales problem you are ever likely to meet in a lifetime in the selling field.

Let us tell you about our Electrifier System that will enable you to sell any line or proposition. Best of all, let us show you how you can quickly become a Master Salesman. This free book gives full information about this remarkable System of Salesmanship Training and Employment Service. It will show you how easily you can learn this fascinating and paying profession at home in your spare time. Mail the coupon NOW.

National Salesmen's Training Association

Dept. 15-H Chicago, Ill.

National Salesmen's Training Association
Dept. 15-H, Chicago, Ill.

I simply want to see the facts. Send me your book "Modern Salesmanship" and Proof I can become a Master Salesman. Also tell how you can help me to a position and send list of lines and openings for Salesmen.

Name.....

Address.....

City..... State.....

Age..... Occupation.....

Popular Science Monthly

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Copyright, 1922, by the Modern Publishing Co.
POPULAR SCIENCE MONTHLY
125 West Thirty-ninth St., New York City

Issued monthly. Single copy, 75 cents.
Yearly subscription for any part of the world,
\$3.00.

Advertising rates on application. Entered as
second-class matter Dec. 28, 1915, at the Post
Office at New York under the act of March 3,
1879. Entered as second-class matter at the
Post Office Department, Canada. Printed in
U. S. A.

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permission. H. J. Fisher, President; R. C.
Wilson, Vice-President; G. B. Capen, Secre-
tary and Treasurer.

\$100 in Prizes Offered in This Issue—See pages 31, 66, and 83

Make Radio a Profession Instead of a Plaything

IT is said that opportunity knocks but once in a man's lifetime. But there are thousands of opportunities knocking at your door right NOW. Get into Radio as a Big Money Making Profession. Here is how:

Become a Radio-trician

A Radio-trician is a person thoroughly proficient in designing, constructing, installing, maintaining, operating, repairing and selling complete Radio transmitting and receiving stations and outfits, by means of which he may pass U. S. Government Examination and secure a First-Class Operator's License for commercial land or sea service or as broadcasting operator.

A Radio-trician means to Radio what Electrician means to Electricity.

MILLIONS upon millions of dollars are being invested in Radio by far-seeing business men and manufacturers throughout the world. Nearly a million Radio sets are already in use. Yet the industry is still in its infancy.

Thousands of men are needed in Radio. They are needed—to design Radio sets—to invent new Radio improvements; they are needed to manufacture Radio equipment and to install it; they are

needed to maintain and operate the great broadcasting stations and the small Radio sets; they are needed to repair and sell Radio apparatus; they are needed to operate aboard ship and at the transoceanic land stations.

Hundreds Getting Wealthy

Hundreds of men are already growing wealthy through this new wonder science. The openings for more men are everywhere. Whatever interest you may have in Radio can be turned into gold.

If you are a young man of ambition, anxious to get into a profession with a field that is unlimited, get into Radio—become a Radio-trician. If you are a dealer wishing to become thoroughly familiar with Radio so that you can sell Radio apparatus, become a Radio-trician. If you are an amateur, learn Radio thoroughly from every angle so that you may make money out of this business instead of using it only as a plaything or hobby. Now is the time for men of red blood, men of vision, to become Radio-tricians.

5,000,000 per Week for Radio

"Do you realize that America is now spending about \$5,000,000 a week for radio equipment? Do you know that the unfilled orders of one radio manufacturing company alone amount to \$50,000,000? Another conservative manufacturer expects to be turning out \$25,000 worth of receiving sets daily.

"It is safe to estimate that in these times of depression, when people were supposed not to have money to spend, the American public has already invested \$100,000,000 in little boxes and tubes and coils of wire whose sole function is to bring entertainment or information into the home. And this is only the start. An annual radio business of \$400,000,000 is confidently expected.

"With the probable establishment of from 12 to 15 powerful broadcasting stations that will cover the entire country—not to mention a host of other public and independent stations—and with the certainty that improvements in apparatus will keep up sales for years to come, it is undeniable that radio has within a period of six months leaped up as a vast national utility on a par in promise with the automobile, the motion pictures, and with public services like the telephone and electric railways."—From *Popular Science Monthly*.



Photograph of one of the large Broadcasting stations. Government License required to operate this station. Certified Radio-tricians are qualified to pass Government examinations.

Radio Headquarters

The National Radio Institute is preparing Radio-tricians by mail in spare time at home. Over eight thousand students and graduates have become proficient in this splendid field through the instruction given by this pioneer school during the past seven years. Every phase of Radio is taught from the ground up. Knowledge is imparted through personally corrected lessons, actual practice and actual assembly of Radio Apparatus.

Through our copyrighted books, diagrams, problems, principles and practice on instruments we send you, the National Radio Institute is making Radio-tricians throughout the country.

WRITE FOR BOOK

Here is a profession which is paying enormous earnings to men all over the country today—a profession that will make hundreds of men wealthy—a profession far more lucrative than that of any other technical or mechanical employment you can secure.

The world is aflame with radio. What are you going to do to "cash in" on the demand for men, for equipment, for experience? Are you going to sit idly by wondering what it is all about, or are you going to make the most of this, the greatest opportunity presented to men of ambition in 50 years?

Write at once for the complete catalog to the National Radio Institute. This is the turning point in your life. Upon your decision this instant may depend your entire future. Mail the coupon, or write a letter NOW—for your own sake.

NATIONAL RADIO INSTITUTE

Radio Headquarters

Dept. 1135

WASHINGTON, D. C.

NATIONAL RADIO INSTITUTE

Radio Headquarters
Dept. 1135, Washington, D. C.

Please send me your catalog "How to Learn Radio at Home", describing your Home Study course which will qualify me to become a Radio-trician.

Name.....

Address.....

City..... State.....

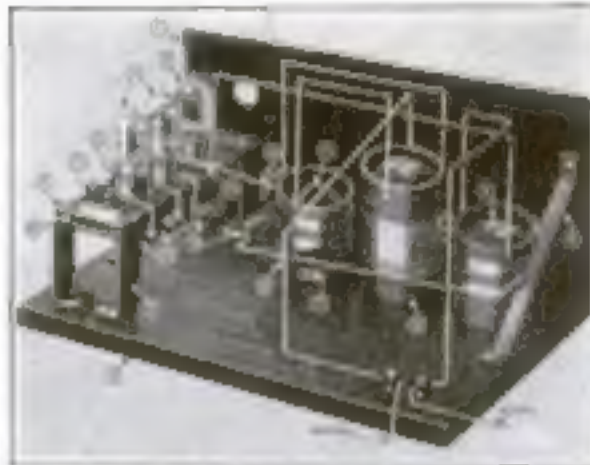
Make Your Own RADIO SET

POPULAR SCIENCE MONTHLY
Will Furnish Reliable Blueprints

For men who like to make things at home with tools **POPULAR SCIENCE MONTHLY** is now publishing, in addition to its popular woodworking plans, two invaluable radio blueprints. These prints are easy to understand; the receiving sets they describe require the fewest possible number of purchased parts.

\$125 Set for \$40 Should Receive 500 Miles

under favorable conditions, if a long, high aerial is used. The blueprint contains working drawings, instructions, and bill of materials of a two-stage regenerative receiving set that a professional would be proud to own. It comprises a variocoupler and an Armstrong two-variometer-regenerative tuning circuit coupled, if desired, with two stages of audio frequency amplification. The tuning coils have been selected because of the ease with which they may be constructed at home. In this set have been incorporated the best features of several types of outfits. It will tune from 180 meters to about 600 meters with remarkable sharpness and selectivity.



The vacuum tube set with two stages of amplification, from rear of panel

Crystal Set Should Receive 25 Miles

For amateurs who wish to start with a simpler set a second blueprint of a crystal detector outfit has been prepared. This set goes the limit in its class. Among other features it contains a variocoupler with an unusually long wave-length range, a unique detector, and a special variable step-by-step condenser. With an adequate aerial this set should receive broadcasts up to 25 and sometimes 50 miles. It can be made for \$15.



The crystal detector set and tools used in its making

CHECK COUPON BELOW

Popular Science Monthly, 7/23
725 W. 39th St., N. Y. City
Send me items checked below, for which amount is enclosed.

- ☐ Blueprint for making \$125 Two-Stage Receiving Set 25 cents
- ☐ Blueprint for making Crystal Detector Set 25 cents
- ☐ Standard Broadcasting Map, Size 15x20 inches 25 cents

Name

Address

Our Standard Broadcasting Chart

THIS famous map of the United States, corrected up to date, showing all the great wireless broadcasting stations, with their locations, call letters, wave lengths, ranges, and other details valuable to every owner of a receiving set, will be sent to any reader on receipt of 25 cents. It shows what programs are available in your region and what kind of radio set you will need to hear them regularly and clearly.

For Safer Flying

An Editorial Prepared Especially for **POPULAR SCIENCE MONTHLY** by the Aeronautical Chamber of Commerce of America.

FOR every person hurt in civilian flying last year, 6701 safe flights were made—an average of 138,440 miles flown for every casualty.

The comparative safety of commercial aviation, illustrated by such figures, indicates that regular travel in great flying ships, possibly similar to that shown on this month's cover of **POPULAR SCIENCE MONTHLY**, will develop rapidly in the United States. We may expect general, scheduled air transport in large craft within five or 10 years.

Several problems of safety must be met, however, before aviation becomes universally popular. Analysis of accident figures for the year makes clear these problems.

The Cross Country Record

Three million miles were covered last year by regular organizations in cross country flying, without a fatality. These figures are based on signed statements of 125 operators, with 600 planes, or approximately half the civilian and commercial machines in the United States. These operators in 12 months made 130,736 flights, and carried 122,612 passengers. It is true there were accidents—24 in all; and 6 persons were killed, but not in cross country flying. Three lost their lives because of unauthorized stunting, two from carelessness in allowing people on the field while machines were landing, and one in a storm.

As nearly as can be estimated, the gipsy or itinerant aviators operated as many machines as the responsible companies, and flew as many miles with an equal number of passengers. They are responsible for perhaps the majority of the 90 accidents not attributable to the commercial companies. In these 90 accidents 49 persons were killed and 89 injured.

With the exception of a few accidents on which full reports have not yet been received, the mishaps suffered during 1921 by gipsy fliers and regular commercial flying organizations may be classified under the following causes:

Poor fields, or lack of them, 20; lack of weather data, 4; lack of route data or flying limitations, 10; stunting, 29; faulty craft, 4; faulty engine, 9; faulty accessories, 9; collision in air, 2; carelessness on field, 8; piloting, 49; unknown, 8.

Government Control Is Advocated

Had we possessed facilities for licensing aircraft and pilots, nearly all these accidents would have been averted. A government system of jurisdiction will eventually stop stunting—the cause of 40 per cent of gipsy accidents—except in military training, or tests. This Federal jurisdiction is provided for in the Wadsworth Bill now in Congress, creating a Bureau of Civil Aviation in the Department of Commerce.

Accidents due to inadequacy of landing fields and flying routes, as well as to flying with defective planes, may be cut down under government control.

Use of radio, with direction finder, wireless compass and telephone system, combined with enforced caution by all operators, will reduce accidents due to other causes and will warn of storms.



"Don't wait until it's too late"

WHEN I was your age, Tom, I was just where you are today. I had what was then considered a good job in Black & Turner's Accounting Department. My friends predicted great things for me.

"Then your mother and I were married and pretty soon we began to need more money. But when I discussed the salary question with the head of the department he told me that the firm was paying me all my work was worth.

"I tell you, son, it was a bad night when I brought that news home to your mother.

"It has been the same way ever since. Man after man has been advanced over my head while I have just plodded along.

"And the pity of it is that one word would have changed my whole life!

"Training! That was all I needed.

"I had as much energy and ambition and as good a brain as any of the men who went ahead of me, but when the bigger jobs opened up I wasn't equipped to step into them.

"Don't wait until it's too late, Tom. My own life would be a different story if some one had only talked to me as I am talking to you today."

ASK any man of 40 or 50 what he would do if he could only go back and start over and he will tell you that he would study his work.

These older men speak from experience. They know that every year it becomes harder and harder for any man to win even moderate success without specialized training.

This is particularly true of the young man in business. For business is becoming more complex every day. And as it becomes more complex, there is increasing demand for men who are trained to do some one thing well.

Note what these men have accomplished through spare-time study:—

James G. Vincent was earning barely a living wage when he enrolled with the International Correspondence Schools. Today he is one of the Vice-Presidents of the Packard Motor Car Company.

Six months from the day Frank E. Fehman enrolled for the I. C. S. Advertising Course he started an agency of his own. Today he is Vice-President of Lord & Thomas and President of the New York Advertising Club as well.

J. G. Kingsbury, President and Treasurer of the Grant Manufacturing Co., is a former I. C. S. student. So are Overton Fulton, Secretary and Treasurer of the Alabama Fuel & Iron Co., and J. F. Richman, Production Manager for the Cole Motor Company.

Robert E. Ramsey, former editor of Advertising and Selling, and now Vice-President of the J. F. Newcomb Company, is another man who says that the I. C. S. laid the foundation for his success. So does Arthur B. Hall, of Boston, Mass., who won the Associated Advertising Clubs cup for the best sales letter campaign.

Frank A. Rayer rose from assistant shipping clerk to Traffic Manager of the National Paper Can Company; Clarence W. Collins became Freight and Passenger Agent with the Southern Pacific Railroad; and George A. Griebie, of The Griebie Co., erected more than \$4,000,000 worth of buildings in Cleveland in 1920.

THE success of the International Correspondence Schools in Business Training, as well as in technical subjects, has been due not only to the personal, problem-solving method of instruction of which they were the originators, but also to the high business and professional character of the men behind the courses.

Among the more than 300 men who have contributed their experience and advice to the preparation of I. C. S. courses are:—

J. Lee Nicholson, First President of the National Association of Cost Accountants; Edgar F. Trask, Assistant Naval Architect, The William Cramp & Son Shipbuilding Co.; Charles J. Nasmith, P.A.A., C.P.A.; Dr. Owen L. Shinn, Professor of Chemistry, University of Pennsylvania; Stanley Bhaader, Telephone and Telegraph Engineer, New York Central Railroad; J. H. King, Research Engineer, Babcock & Wilcox Company, New York; Bradley Stough-

ton, Mining Engineer and formerly Secretary of the American Institute of Mining Engineers; E. G. Whitham, Special Traffic Agent of the American Express Company; A. Hamilton Church, the well-known industrial engineer; Edward P. Mooney, Jr., A.M., C.P.A., Professor of Accounting at the University of Pennsylvania; and Dr. Clarence Stratton, Director of English in the Cleveland Public Schools.

Whatever the course, if it is an I. C. S. course, you can be sure it represents the best thought of men who are leaders in that particular field and is drawn from their practical experience.

Why not at least find out what the I. C. S. can do for you? It takes but a moment to mark the work of your choice, tear out and mail the coupon printed below. There's no obligation and not a penny of cost, yet that one single act may be the means of changing your whole life. Today—not "Tomorrow"—is the day to take your first definite step toward Success.

INTERNATIONAL CORRESPONDENCE SCHOOLS Box 7090-B, Montreal, P. Que.

Without cost or obligation on my part, please send me full particulars about the subject before which I have marked an X in the list below:—

BUSINESS TRAINING DEPARTMENT

- | | |
|---|---|
| <input type="checkbox"/> Business Management | <input type="checkbox"/> Salesmanship |
| <input type="checkbox"/> Industrial Management | <input type="checkbox"/> Advertising |
| <input type="checkbox"/> Personnel Organization | <input type="checkbox"/> Letter Writing |
| <input type="checkbox"/> Traffic Management | <input type="checkbox"/> Foreign Trade |
| <input type="checkbox"/> Business Law | <input type="checkbox"/> Stenography and Typing |
| <input type="checkbox"/> Banking and Banking Law | <input type="checkbox"/> Business English |
| <input type="checkbox"/> Accounting (including C.P.A.) | <input type="checkbox"/> Civil Service |
| <input type="checkbox"/> Minimum Cost Accounting | <input type="checkbox"/> Railway Mail Clerk |
| <input type="checkbox"/> Bookkeeping | <input type="checkbox"/> Common School Subjects |
| <input type="checkbox"/> Private Secretary | <input type="checkbox"/> High School Subjects |
| <input type="checkbox"/> Business Spanish <input type="checkbox"/> French | <input type="checkbox"/> Illustrating |

TECHNICAL AND INDUSTRIAL DEPARTMENT

- | | |
|--|--|
| <input type="checkbox"/> Electrical Engineering | <input type="checkbox"/> Airplane Engineer |
| <input type="checkbox"/> Electric Lighting | <input type="checkbox"/> Architect |
| <input type="checkbox"/> Mechanical Engineer | <input type="checkbox"/> Contractor and Builder |
| <input type="checkbox"/> Mechanical Draftsman | <input type="checkbox"/> Architectural Draftsman |
| <input type="checkbox"/> Machine Shop Practice | <input type="checkbox"/> Concrete Builder |
| <input type="checkbox"/> Railroad Positions | <input type="checkbox"/> Structural Engineer |
| <input type="checkbox"/> Gas Engine Operation | <input type="checkbox"/> Chemistry |
| <input type="checkbox"/> Civil Engineer | <input type="checkbox"/> Pharmacy |
| <input type="checkbox"/> Surveying and Mapping | <input type="checkbox"/> Automobile Work |
| <input type="checkbox"/> Mine Foreman or Engineer | <input type="checkbox"/> Agriculture and Poultry |
| <input type="checkbox"/> Steam Engineering <input type="checkbox"/> Wireless | <input type="checkbox"/> Mathematics |

Name _____
Home Address _____
City _____ State _____
Occupation _____
Persons residing in Canada should send this coupon to the
International Correspondence Schools Canadian, Limited,
Montreal, Canada.

QUICK-ACTION ADVERTISING

HERE READERS AND ADVERTISERS MEET TO TRANSACT BUSINESS

Rate 25 Cents a Word. Advertisements intended for the September issue should be received by July 1st

AUTOMOBILES AND ACCESSORIES

PATENTS—Write for free illustrated Guide Book and Evidence of Conception Blank. Send model or sketch and description of invention for our opinion of its patentable nature. Highest references. Reasonable terms. Victor J. Evans & Company, 186 Ninth, Washington, D. C.

AUTOMOBILE owners, garagemen, mechanics, repairmen, send for free copy of our current issue. It contains helpful, instructive information on overhauling, trouble shooting, wiring, carburetors, storage batteries, etc. Over 140 pages, illustrated. Send for free copy today. Automobile Digest, 513 Butler Bldg., Cincinnati.

AMERICAN Garage & Auto Dealer publishes each month interesting and helpful suggestions and information on sales, merchandising, advertising, business management, accounting, welding, cutting, brazing, practical and progressive hints for office and shop, for "small-town" automobile dealers, garagemen, repairmen, mechanics. Subscription price \$1.00 per year. (Money back if not satisfied.) Sample copy on request. American Garage & Auto Dealer, 1005 Lake View Building, Chicago.

GARAGE, repair or barbershop. Write now for complete proposition that enables you to quickly and profitably make new or repair old flat or "V" belts for cars, trucks, tractors or small shop machinery. Lakewood Fabric Belting & Mfg. Company, 1818 Highland Avenue, Lakewood, Ohio.

WEATHER-PROOF your car. Apply Tapes Liquid Auto Glaze with a chemist cloth. It dries leaving a dust-free, hard, rich lustrous finish. Mud and water don't affect it. Being used everywhere. \$1.50 per can. Prepaid. Rosenthal Chemical Co., Ponfith, Montana.

FORD ACCESSORIES

SPRESTER Flaps. See "Red-4-Kut" ad, page 28.

PROTECT your motor; save time, money, clothes and temper with our superior, water-proofed, detachable belts for Ford's. Regular price 50c each. Six (6) belts sent postpaid for \$1.25. State model when ordering. Money refunded if not entirely satisfied. Lakewood Fabric Belting & Mfg. Company, 1818 Highland Avenue, Lakewood, Ohio.

FORD Car Repair Book sent free. This complete, well illustrated, valuable book explains in a simple way the causes and cures of over-heating, repairing Ford tires, curing piston ring troubles, carburetor adjustments and repairs, converting rods, transmission troubles, care and repair of rear axle, stopping axle grease leaks, also covers practically every other phase of Ford car repairing. Send 50c coin for three month trial subscription and get the valuable repair book free. Ford Owner and Dealer Magazine, 303 Montgomery Bldg., Milwaukee, Wisconsin.

FORD run 34 miles per gallon on standard gasoline or half kerosene, using our 1923 carburetor. Increased power, style for all nature, attach yourself. Money back guarantee. 30 days trial. No profits to agents. Air-Fuelum Carburetor Co., 3232 Madison Street, Dayton, Ohio.

WANTED—Agents to sell Kreiner's Automatic Air Valve for Fords. Guaranteed save 15% to 40% gasoline. Large commissions. Exclusive territory. Kreiner Mfg. Co., 1017 Title Guaranty Bldg., St. Louis, Mo.

ELECTRICAL

ELECTRICITY for 10c per hour. Motion auto generator. Operates on any make automobile. Produces electricity for moving picture machines, theatres, schools, churches, homes, etc. Write for free particulars. Monarch Theatre Supply Co., Dept. A-114 South Wabash Avenue, Chicago.

WANTED

USED Correspondence Courses wanted. All subjects; all subjects. Courses bought, sold, exchanged. Bufiles 1099 free. Instruction Correspondence Exchange, 1945 Broadway, New York.

WANTED—Representatives to every factory in the United States. Popular Science Monthly, 225 West 39th Street, New York.

WIRELESS

GALENA CRYSTALS. One half dozen postpaid for one dollar. American Technical Laboratories, 31 Post Office Place, Salt Lake City, Utah.

BUILD your own Radio receiver for \$5.00 and hear the concerts nightly. Our blueprint No. 240 explains all. Price \$1.00. Experimenters Information Service, 45 Flushing Avenue, New York.

TOOLS AND SUPPLIES

13 TOOL handy set, made of best steel. The most useful and practical tool on the market. Postpaid \$1.25. National Specialties, 327 Union Square, New York City.

DUPLICATING SERVICES

WANT a "modern" duplicator to print typewritten or pen written letters, drawings, lessons, maps, bills, forms, maps, specifications or anything in one or more colors. Prints two a minute. \$2.25 up. Special sale no. 30 days free trial. Booklet free. J. V. Durbin-Ransom Company, Pittsburgh, Pennsylvania.

DUPLICATE keys for all Yale and similar locks made with our up-to-date machines. \$2.00 to \$25.00. Free catalog. Harrison & Co., Dept. 4-B, 16 Broadway, New York.

MR. ADVERTISER: Ask to-day for a copy of the "Quick-Action Advertising Rate Folder." It contains some really important facts which will prove interesting and valuable to you. It also tells "How You Can Use Popular Science Monthly Profitably." You'd like to know, wouldn't you? Manager Classified Advertising, Popular Science Monthly, 225 West 39th Street, New York.

TRADE SCHOOLS

DENTAL Laboratory work taught three to ten months practical work; no book-study; no license necessary. Free catalog. J. McCarrie School of Mechanical Dentistry, 34 West Lake, Chicago.

EARN more money—Learn sign painting, scenic painting, showcard writing, auto painting, paper hanging, decorating, painting, marbling, at Chicago or at your home. Chicago Painting School, 137 West Armita Avenue, Chicago.

MAKE money writing for newspapers. \$2000 to \$10,000 yearly; good pay for spare time work. Experience unnecessary. Men and women needed everywhere; editorial, reporting, special articles, stories, sports writing, local correspondence, etc. Special privileges, press pass, etc. Qualify quickly in spare time at home under veteran newspaper men. Fascinating book free. Explains everything. Write today. Newspaper Training Association, Dept. 47, New York City.

MAILING LISTS

3675 FARMERS, every Nebraska county, \$1.00. Jensen's Service, Box 740, Omaha, Nebraska.

Are YOU Reaching This Vast Audience of Buyers?

These little messages of big business—the Classified Advertisements—receive consideration from interested people in every part of the world. And they are of sufficient importance to induce those people to respond in terms of dollars and cents. This statement is based on facts—voluntary letters of appreciation sent in by advertisers who KNOW the pulling power of a magazine that reaches a quarter of a million READERS every month.

A new advertiser has just written us as follows:

"Popular Science Monthly has brought answers from Mexico, Cuba, Canada, Hawaii and all parts of the United States. I think it covers a large territory and one that is profitable."

Of course it does. And YOU can cover that same territory—reach that same audience and transact real business by putting your message in the next issue. The rate is only 25 Cents a Word and the results will speak for themselves. Why not try it?

Classified Advertising Manager
POPULAR SCIENCE MONTHLY
225 West 39th Street
New York City

TELEGRAPHY

TELEGRAPHY—(Morse and Wireless) and railway accounting taught thoroughly. Big salaries, great opportunities. Select largest school. All expenses low—no extra large part. Catalogue free. Dodge's Institute, Quind Street, Valparaiso, Indiana.

BOATS AND LAUNCHES

PALMER four cycle motor for row boats, yacht tenders. Price \$95.00. Also two and four cycle to seventy-five horsepower. Catalogue free. Palmer Bros., Oak City, Connecticut.

DARROW steel motorboats, rowboats, sectional boats, motor and everything from the smallest skiff to the 25-foot pleasure or work boat. We also have a practical "build your own boat plan." Fourteen years of successful boat building given or confidence to say that "Darrow" boats give more service per dollar than any others. Catalogue and prices free. Darrow Boat Works, Adrian, Michigan.

RADIO SUPPLIES

RADIO cabinets—We build special cabinets and cases to order. Tell us what you want and get our price. National Cabinet Co., Dept. R-3, Dayton, Ohio.

PHOENIX Radio apparatus. Phoenix radio fans in Central states are listening to nightly to concerts, press reports, etc., broadcasted by Eastern stations. You can do the same. Write for catalogue Series M3. Phoenix Radio & Parts Co., Cincinnati, Ohio.

BUILD your own radiophone. Instruction book for radio. Radio Service Institute, 14th and O Streets, Washington, D. C.

BUILD radio sets. We supply parts or complete units. Catalog 15 cents. Easily understood assembly drawings. Crystal detector set, non-regenerative receiver, regenerative receiver, 2 step amplifier, 35 cents each. All five \$1.00. No stamps accepted. Knifield Airline Company, Oswego, New York.

ELIMCO Tube Booklets \$1.38. Elmore Vernier Rheostat \$2.00. Elmore Audio-Frequency Transformers \$6.00, also complete receiving sets. Immediate delivery. Electric Machine Corporation, Indianapolis, Indiana.

SEND ten cents for our new large 32 page catalog describing our course entitled "How to Learn Radio at Home." National Radio Institute, Dept. 1829, 1845 Penn. Ave. N. W., Washington, D. C.

MAKE your own radiophone receiver. It's easy when you have simple directions and diagrams to follow. You can do it at small expense. Our new copyrighted book tells you how. Well bound, attractive, complete with details of radiophone receivers, explanations, symbols, radio formulas, etc. Sent postpaid for 75 cents. Radiophone Service Bureau, 1431a Clifton Street, Northwest, Washington, D. C.

ADDING MACHINES

ADDING or calculating machines. Free trial. Money back guarantee. Connell and Whittuck, 424 Fourth Avenue, Pittsburgh, Pennsylvania.

FREE trial marvelous new adding machine. Adds, subtracts, multiplies, divides automatically. Work equals \$34.00 machine. Price only \$15.00. Speedy, durable, handsome. Five-year guarantee. Used by largest corporations. Write to-day for catalog and free trial offer. Lightning Calculator Co., Dept. C, Grand Rapids, Mich.

FORMULAS

FREE—Formula catalog. Laboratories, 6800 Daylight Building, Chicago.

3000 FORMULAS and recipes—440 pages, \$1.00. Bookwood Book Shop, 70212 South Winchester, Chicago.

FORMULA catalog free. C. A. Lutz, Apartment 341, York, Pennsylvania.

FORMULAS of the better sort. Write for our free catalog. National Scientific Laboratories, 829 Main, Richmond, Virginia.

FORMULAS—Catalogue free. Bartovall Laboratories, 4649-N. Whipple, Chicago.

LABORATORY AND CHEMICAL SERVICE

YOUR chemical or electrical problem solved for Five Dollars. Write to W. Friedman Richards, Consulting Chemist, 320 Washington St., Boston, Massachusetts.

MANUFACTURING

LET us be your factory! Write to-day. Logan Machine Company, 323 South Clinton Street, Chicago, Illinois.

LET us be your machine shop! We build models and will do your manufacturing. Victor Eng. Co., 3824 W. Chicago Avenue, Chicago.

MOTORCYCLES, BICYCLES, SUPPLIES

DON'T buy a bicycle motor attachment until you get our catalogue and price. Shaw Mfg. Co., Dept. 4, Dainton, Kansas.

PARTS for all motorcycles cheap. Schuck Cycle Co., 1922 Westlake, Seattle, Washington.

SEND for big list of slightly used motorcycles on our easy payment plan. Howard Cycle Co., 152 N. Broad St., Trenton, New Jersey.

USED and new parts. Indian, Excelsior, Harley, Roadster, Thor, Henderson, Yale. Get our price lists. Kingshighway Cycle Co., 1166 North Kingshighway, St. Louis, Missouri.

MOTORCYCLE cylinders reground, fitted with new piston rings. \$4.00. Guaranteed. Muncie Piston Co., Muncie, Indiana.

STAMPING NAMES

MAKE \$19.00 hundred stamping names on key checks. Send 25c for sample and instruction. PS Keytag Company, Cohoes, New York.

MOTORS, ENGINES, MACHINERY

\$12.50 will purchase a new 14 h. p. 50 cycle a motor. Get one while they last. Lowman, Belleville, Illinois.

OPTICAL GOODS

ARTIFICIAL eyes \$1. Booklet free. Denver Optic, 608 Barclay, Denver, Colorado.

ULTRAFLEX microscope. Patents pending. Model with magnification gradually variable from 2,500 to 62,500 times. \$1.00. Orders from 100 to 250,000 times. Some of the best. Circular 5-7 free. Specialty Mfg. Co., Milton, Pennsylvania.

Was
\$100
Now
\$55

After July 1st
the price
will be
\$65



\$

4

A
Month
Pays
for
the
Latest
and
Finest
Oliver

Your Last Chance to Save \$45

The present price of \$55 has proved impossible. So to maintain Oliver quality, we announce, with fair warning, that after July 1st, the price will be \$65. If you act quickly, you can take advantage of the present saving of \$45. But note that the coupon has to be mailed at once.

Here is the present offer:

Price \$55. Over a year to pay! Only \$4 a month. Payments so small as to average only about 13 cents a day. That is our easy payment plan on the Oliver. And you have the use of the typewriter while you are paying for it. You may now order direct from The Oliver Typewriter Company and get the latest model Oliver at a saving of \$45 and on payments so easy that you won't miss the money.

A full saving to you of \$45 on the famous Oliver No. 9—our latest and newest model. That is what our new selling plan makes possible. During the war we learned many lessons. We found that it was unnecessary to have such

a vast number of traveling salesmen and so many expensive branch houses. We were able to discontinue many other superfluous sales methods. As a result, \$55 now buys the identical Oliver formerly priced at \$100.

Try It Free—Send No Money

Not a cent in advance. No deposit of any kind. No obligation to buy. The coupon is all you need send. The Oliver comes to you at our risk for five days free trial in your own home.

Decide for yourself whether you want to buy or not.

If you don't want to keep the Oliver, simply send it back at our expense. If you do agree that it is the finest typewriter, regardless of price, and want to keep it, take a year and a half to pay at the easy rate of only \$4 a month.

Only the Coupon!

No pre-payment required. This is a real free trial offer. All at our expense and risk. Fill out and mail the coupon and get the Oliver for free trial. If you should wish further information before requesting a free trial, mark the coupon for the free books mentioned therein. Clip and mail the coupon now.

Canadian Price, \$79

The **OLIVER**
Typewriter Company

110A Oliver Typewriter Bldg., Chicago, Ill.

After July 1st, the price of the Oliver will be \$65. As the present price of \$55 has been widely advertised, we want to be perfectly fair and announce the price change in advance. If you act quickly, you can obtain the \$100 Oliver for \$55. Note that the coupon must be mailed before midnight, June 30th.

THE OLIVER TYPEWRITER COMPANY,
110A Oliver Typewriter Bldg., Chicago, Ill.

☐ Ship me a new Oliver No. 9 Typewriter for five days' free inspection. If I keep it I will pay \$55 as follows: \$2 at the end of trial period and then at the rate of \$4 per month. The title to remain in you until fully paid for. If I make cash settlement at end of trial period I am to deduct ten per cent and remit to you \$49.50.

If I decide not to keep it, I will ship it back at your expense at the end of five days.

My shipping point is _____

☐ Do not send a machine until I order it. Mail me your book—"The High Cost of Typewriters—The Reason and the Remedy," your de luxe catalog and further information.

Name _____

Street Address _____

City _____ State _____

Occupation or Business _____

This coupon not valid unless mailed and postmarked before midnight, June 30, 1923

Brand-New: From Factory to You



BIG SAVING

This beautiful machine is the only brand-new (unused), standard, full-size typewriter with a 4-row, 42-key, 84-character Universal keyboard that you can buy for less than \$100. It comes direct from factory to you at practically the wholesale price of other high-grade typewriters—a remarkable saving.

Free Trial

Use Annell' on your work at our expense, put it to the test for ten days; then if it doesn't satisfy you in every way, return it to us and we will refund even the express charges. You take no risk. Could anything be fairer?

Easy Terms

While you are using the machine, small monthly payments scattered over a period of more than a year make it easy and convenient to own this full-size, brand-new (unused), 4-row, standard-keyboard typewriter.

Mechanical Marvel

Strength and simplicity are the outstanding qualities of this machine. It embodies the ideas and experience of mechanical geniuses who have been making typewriters for generations. Every essential operating convenience is possessed by Annell', including the 4-row, 42-key, 84-character Universal standard keyboard. It will last a business lifetime and is fully covered by an ironclad guarantee.

Send Coupon Today
For Complete Information
about the greatest of all typewriter offers.

Don't miss it. Act now.

ANNELL' TYPEWRITER CO.
832 No. 230 East Ohio Street, Chicago

NOT AN ORDER - MAIL TODAY

ANNELL' TYPEWRITER CO.
832 No. 230 East Ohio Street, Chicago.

Send me complete information about your wonderful typewriter offer; this places me under no obligation.

Automobile Repairshop Shortcuts

Contains over 1,500 time and labor saving methods and devices that have proven exceptionally helpful in repairing or adjusting engine clutches, gear-sets, running gears and bodies, etc., and in managing and equipping shops. Here is the opportunity to study the methods of over five thousand experts who were all striving to find a better way to do some job and to shorten the time required to do it. 1,500 illustrations.

Price, postpaid, \$3.95

Motorcycles, Side Cars and Cycle Cars

Their Construction, Management, and Repair. By VICTOR W. PAGE. Describes fully all leading types of machines. 500 pp., 250 illus., 5 folding plates.

Price, \$3.00

POPULAR SCIENCE MONTHLY
225 W. 39th Street, New York

Quick-Action Advertisements continued from page 6

AMERICAN MADE TOYS

MANUFACTURERS wanted for large production and home-workers on smaller scale for metal toys and novelties, toy soldiers, cannons, cowboys, Indians, Buffalo Bulls, wild animals, whistles, bird-whistles, race horses, prize-fighters, washed pupa, pot and take top, and hundreds of other articles. Hundreds and thousands made complete per hour. No experience or other tools needed. House casting formal complete outfit from \$5.00 up. We buy these goods all year, paying fixed prices. Contract orders placed with manufacturers. Exceptional high prices paid for painted novelties. An enormous business for this year offers industrious men an excellent opportunity to enter this field. Write us only. If you mean real business. Catalog and information from Metal Cast Products Co., 1606 Madison Road, New York.

INCREASE your output of metal toys and novelties by using a casting form hand machine. Write for circular T-5, V. G. Chute, Mechanicsville, New York.

AVIATION

THIS is your chance of a lifetime to become an airplane expert. Write Louis Combs, Chief Engineer, Central Airplane Works, 334 Lincoln Avenue, Chicago.

INVENTORS desiring information write for our free Illustrated Guide Book and Evidence of Copyright Blank. Send model or sketch of invention for our opinion of its patentable nature. Highest references. Prompt service. Reasonable terms. Victor J. Evans & Company, 131 Ninth, Washington, D. C.

MODELS AND MODEL SUPPLIES

WE make working models for inventors and do experimental work, and carry a complete stock of brass parts and model supplies. Send for catalogue. The Plastic Model Works, Tinker Park, Illinois.

MODEL making and experimental work; models ship, expert workmen. Manufacturing, Lammes Model and Experimental Works, 625 W. Jackson, Chicago.

FOR THE HOME

GRANDFATHER clock works \$5.00. Build your own case. Instructions free. Make good profits selling your friends. Clock works with chains for old or new cases. Write for full particulars. Clock Co., Kinsdown, Pennsylvania.

HEMSTITCHING and pressing attachment works on any sewing machine, easily adjusted. Price \$2.50 with full instructions. Oriental Novelty Co., Box 11, Corpus Christi, Texas.

FOR BOYS

PLAY Mouth-organ. Complete, easy instruction. The Blue, Publisher, Bowling Green, Ohio.

WonderBoat, the baffling mystery! What makes it go? Built in hour. Blueprints, directions, etc. W. A. Johnson, College View, Nebraska.

ASTROLOGY

HINDU astrology. Dr. Himmla, of East India, the world's greatest clairvoyant astrologist, tells your life story from the stars. Send date of your birth, 10c. stamp for trial reading. Dr. W. E. Himmla, Phoenix, Virginia.

MAGIC world's secret, sure method of obtaining your desires. Postpaid for dime. Stanley, 143 Miller, Brooklyn, N. Y.

HOROSCOPES

HOROSCOPE—complete—Dr. Give birthdate. Hall, Station R, New York.

LIFE revelation with large pictorial chart showing character, talents, suitable occupation and description of ability. Send 10c birthdate. Antelope Company, Dept. 1121, Minneapolis, Pa.

MR. ADVERTISER: Ask to-day for a copy of the "Quick-Action Advertising Rate Folder." It contains some really important facts which will prove interesting and valuable to you. It also tells "How You Can Use Popular Science Monthly Profitably." You'd like to know, wouldn't you? Manager Classified Advertising, Popular Science Monthly, 225 West 39th Street, New York.

OFFICE DEVICES

ADDRESSING machines, multi-graphs, duplicators, folders, check writers, makers, dictating machines, at about half new cost. Pruitt, 170-E North Wells, Chicago.

MISCELLANEOUS

EXCHANGE job. Interesting letters through our Club Send stamp. Betty Lee, 18 East Bay, Jacksonville, Florida.

MAIL old gold, unused postage, war and third stamps, Liberty Bonds, silver, platinum, diamonds, jewelry, watches, false teeth, magnets, points, etc., new or broken. Cash immediately. Held ten days, returned if unsatisfactory. Ohio Smelting Co., 235 Lennon Building, Cleveland.

EXCHANGE chess letters with new friends. Lots fun. Send stamp. Eva Moore, P. O. Box 4389, Jacksonville, Florida.

SHAVE—without brush or soap. Skin left smooth and soft, guaranteed. Tube 50c. J. Gosh, Washington, D. C.

10 DIFFERENT strings of Japanese beads for children for 10c. T. T. T. Sakai Bros., Honolulu, Tokyo, Japan.

TATTOOING supplies. Illustrated catalogue free. Prof. Waters, 1030 Randolph, Detroit.

LUMINOUS paint, bottle 50c. Laboratories J. Dos 11a Portland, Oregon.

EARN money taking orders for Rubber Stamps and Calling Cards. Good commission. Send ten cents for samples and terms. Rubber Stamp and Card Works, 901 Dorcy St., Chambersburg, Pennsylvania.

ADVERTISING

FREE AD-Guide giving interesting rates for advertising in magazines and weeklies. Concordia Magazine, 210 E. York, Pennsylvania.

ADVERTISE in 24 metropolitan dailies, 25 words, \$15. Highest Guide listing 1000 publications, 1c stamps. Wade, Baltimore Bldg., Chicago.

Popular Science Monthly

PATENTS FOR SALE

AUTO signal, visible all directions, advance of danger manually operated, illuminated, disappearing, right, left, stop, stop, stop any vehicle. All year seller. Advertiser, 1001, F. A. Cox, 27 West Ohio Street, Chicago.

PATENT No. 1,333,128 U. S. for sale outright or no royalty. A valuable and handy article. It will pay you to investigate. G. J. Olson, 428 Alberta Street, Portland, Oregon.

RALE U. S. and Canada patent. Hygiene garter. Physican indorsements furnished. Universal need. L. O. Warren, Westwood, Calif.

FOR sale Patent No. 1,406,531 Pliers and Wrench. Edward Brown, 56 Kelly Street, Bristol, Connecticut.

SCENERY FOR HIRE

SETTINGS for Opera, Plays, Minstrels. Flush Drapes. Catalog. Amelia Grinn, Philadelphia.

TYPEWRITERS AND SUPPLIES

TYPEWRITERS all makes \$15.00 up. Guarantee five years, one month's free trial. Special proposition to agents. Send for catalogue before purchasing. Typewriter Manufacturing Exchange, Fordham, New York.

ALL makes. \$100 used typewriters, 80 up. Free trial. Write for illustrated Bargain List. Northwestern Typewriter Exchange, Dept. 2, 320 Geesie St., Chicago.

PRINTING, ENGRAVING, MULTIGRAPHING

LITTERHEAD, envelopes, 500 \$3.50. Samples free. Quality Printery, Marietta, Ohio.

100,000 1 x 2 1/2 labels, \$3.00. 1,000, 1/2. Save 80%. Wolf Labels, Station R, Philadelphia.

BETTER printing for less money! Send for our large package of samples of hundreds of items every user of printing is interested in. These samples worth dollars will be sent for 10 cents to pay postage. Ernest Fautus Company, 423 South Dearborn Street, Chicago.

ENVELOPES business, terminal stationery. Bampton, Stamp. Daniels P. Company, Piquette, Pennsylvania.

PRINTING—1000 bond letter heads, envelopes, cards, etc., \$3.00. Wedding announcements, \$3.00. 1000 of 50, The Arrow Press, 112 N. LaSalle St., Chicago, Illinois.

WOOD engraving of your signatures and rubber stamps, 50c. John P. W. Smith, 117 Montgomery St., San Francisco, California.

CITY printing at country prices. Samples free. Royal Printers, Sagamore, Ohio.

STATIONERY

ARTISTIC box of stationery, your name and address or monogram embossed \$1.00. Majestic Monogram Company, 290 Third Avenue, New York.

POULTRY AND LIVE STOCK

BREED squabs. Book free. C. H. Hens, Madison Heights, 77, Massachusetts.

E. T. SPENCER, Originator Spencer Turkey Farm 9 Case St., Santa Cruz, California. Booklet free.

INSECTS WANTED

SPEND spring, summer, fall, gathering butterflies, insects. I pay hundreds for collections. Some \$1 to \$7. Sample with my pictures, price list, instructions. Send 25c (not stamps) for Illustrated Prospectus. Sinclair, Dept. 7, Orem Park, California.

EDUCATIONAL AND INSTRUCTION

CORRESPONDENCE course at less than half original price. Any school, any subject for men or women. Bulletin 1084 free. Used courses bought. Insurance Correspondence Exchange, 1895 Broadway, New York.

BOOKKEEPING self-taught in a week with "Thinker's Common Bookkeeping." Price \$4. Newton A. Duhm, P.O. Box 100, New York.

LINCOLN-JEFFERSON University. Home study in Academy College, Theological, Law, Music, Pharmacy, Business and Graduate schools, leading to degrees. Box G, 94 W. Randolph Street, Chicago.

DOUBLE entry bookkeeping mastered in 60 hours! guaranteed! diploma. International Bookkeeping Institute, Springfield, Missouri, Desk 10.

BECOME master dealer—Learn secrets real estate success. Big profits. Independence. Luthers. Guaranteed. Special offer free. Stephen Kistler, 619 Winer, Maunle, Indiana.

WHAT'S Your Future? Develop winning personality, be popular. Higher business positions, social acquaintance, and larger earning capacity. Success depends largely on personality, no matter what business you are in or have studied. It's a wonderful thing. Free literature. Write today. Personal Service Bureau, Box 1235, West Palm Beach, Florida.

THE most profitable art as well as the easiest to learn. Sign paintings and show-card writing. Complete course \$2.50. Hall's Sign Shop, Franklin Square, Worcester, Massachusetts, Dept. B.

LANGUAGES

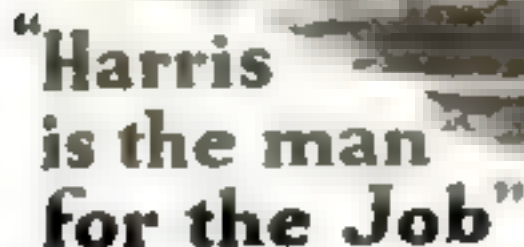
WORLD-ROMIC System, Masterkey to All Languages. Six textbooks, \$1.75. French Chart, 37c. Spanish, 37c. Pronunciation tables, 70 languages, 30c each. Language Publishing Company, 8 West 45th Street, New York.

PHONOGRAPHS, RECORDS

BUILD your phonograph. Quality phonographs. Highest quality records and electric guitars, two arms, reproducing amplifiers, case material and accessories. Free blue prints and building instructions. Inc. saving. Wonderful results. New catalog mailed for ten cents. Hooper Manufacturing & Supply Co., Phonograph Supply Department, 518 Baldwin Block, Indianapolis, Indiana.

MR. ADVERTISER: Ask to-day for a copy of the "Quick-Action Advertising Rate Folder." It contains some really important facts which will prove interesting and valuable to you. It also tells "How You Can Use Popular Science Monthly Profitably." You'd like to know, wouldn't you? Manager Classified Advertising, Popular Science Monthly, 225 West 39th Street, New York.

Quick-Action Advertisements continued on page 9



Quick-Action Advertisements continued on page 11

Quick-Action Advertisements continued on page 13

The One Necessary Radio Book

Answers All Your Questions

WHAT are you going to do when perplexities confront you in operation or repair of your radio receiving set? Quit the game in despair? Call in a radio-wise neighbor? Or will you make each difficulty a stepping stone to greater radio knowledge and enjoyment by turning to the pages of the one popularly priced radio book that answers every question?

"The Standard Radio Guide"

answers every question of the radio beginner or the man who wants to know more about radio before he begins. Because it was inspired in large part by the practical, money-saving replies sent by the Information Department of POPULAR SCIENCE MONTHLY to perplexed radio amateurs in all parts of America, this attractively bound handbook is a gold mine of easy-to-read radio information.

Written by the staff experts of POPULAR SCIENCE MONTHLY, who for years have been giving America the news of science in simple, nontechnical language, the "Standard Radio Guide" tells you the things you want to know in terms you can understand. In addition, every difficult point is made doubly clear by photographs and diagrams.

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The above photograph, picturing operation of a two-stage receiving set, is typical of the interesting, informative pictures and diagrams scattered through the pages of the "Standard Radio Guide."

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Read This Table of Contents

WHAT RADIO EQUIPMENT YOU WILL NEED—Gives you facts that will enable you to do your "shopping" intelligently.

HOW YOU ASSEMBLE YOUR RECEIVING SET—Tells how to erect the aerial you need and makes clear the simplest method of lightning protection.

HOW TO ADJUST THE SET FOR SIGNALS—Reveals "tuning in" of its mysteries, giving detailed procedure for both the simple crystal set and the advanced vacuum tube regenerative set.

WHAT RADIO STATIONS YOU CAN HEAR—Gives you a list of the more important broadcasting stations, with a map showing location and normal range.

HOW TO MAKE A CRYSTAL DETECTOR RECEIVING SET—Gives complete directions for making an excellent receiving outfit at home with simple tools.

HOW TO MAKE A VACUUM TUBE DETECTOR SET—Gives plans for a more ambitious and unusually sensitive station with which you can tune other stations in or out at will.

IMPORTANT TRICKS AND TROUBLE SPOTS IN RADIO—Is bristful of suggestions that will enable the enterprising amateur to add miles to the effectiveness of his receiving set.

GLOSSARY OF PRINCIPAL RADIO TERMS—Defines the expressions most frequently used in radio.

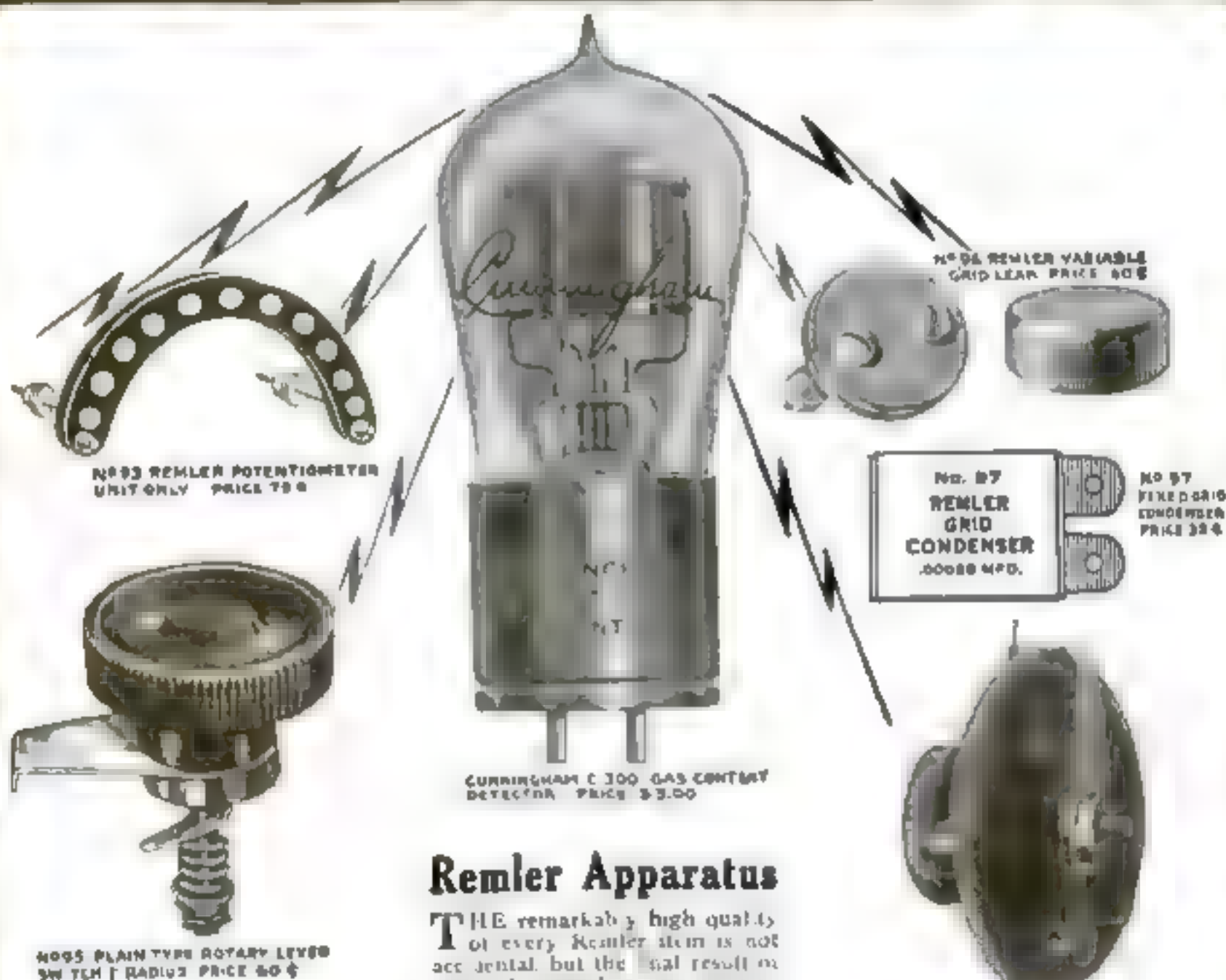
WHAT YOU CAN HEAR WITH A RADIO SET—Describes the broadcasted radio entertainments of today with a sample day's program, and forecasts the future.

HOW WIRELESS SPEECH IS POSSIBLE—Explains how speech is transformed into electric impulses at the transmitting station and how your set receives them.

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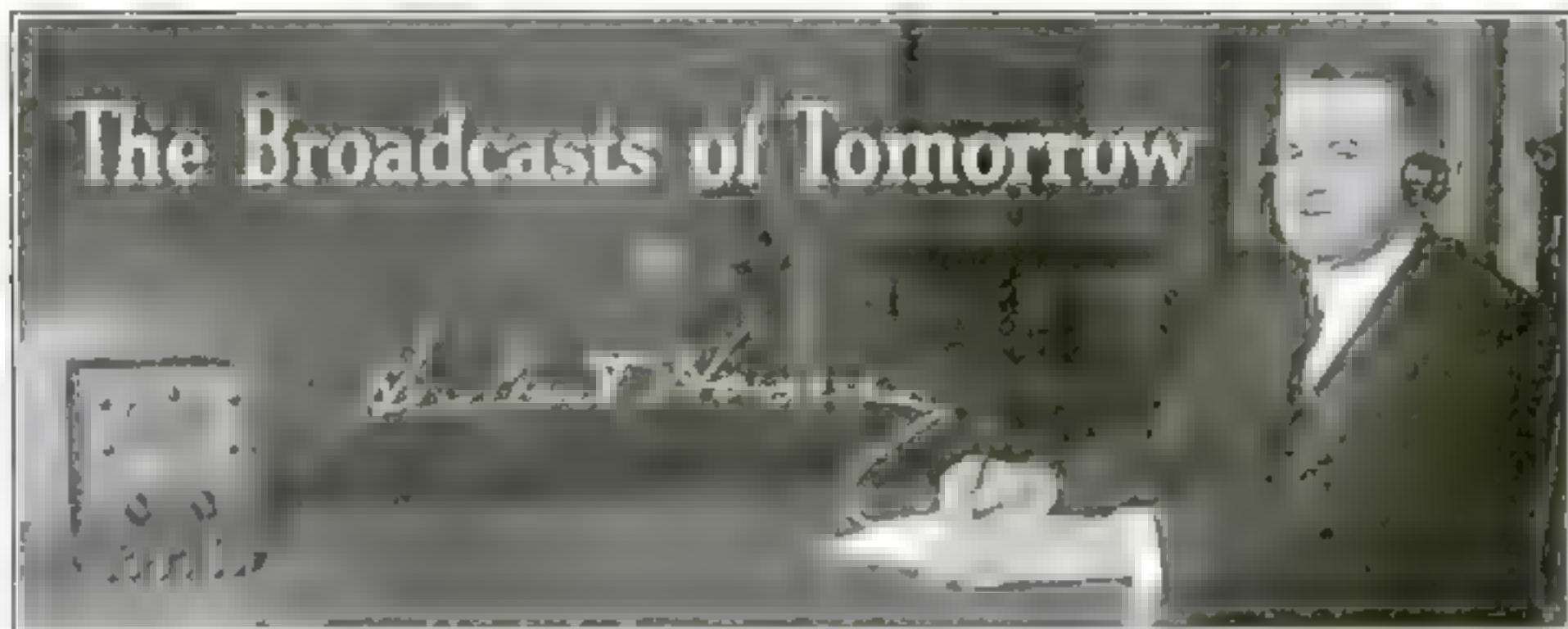
Apparatus that Radiates Quality

Popular Science Monthly

July, 1922; Vol. 101, No. 1
25 Cents a Copy; \$3 a Year



Published in New York City at
225 West Thirty-ninth Street



IN MANY American homes, people are asking, "How are future developments of the radio-telephone likely to affect us?" No one is in a position to answer all the implications of this question. The possible expansion or retrenchment in the broadcasting of entertainment, the extent of lasting public demand for musical programs of the present type, the method by which, in the long run, these programs will be financed—all these matters hinge on unforeseeable contingencies.

Those who have become interested in radio in the past few months have reason to believe, however, that there will continue to be many agencies that will want to supply the public by radio-telephone with interesting information that the public, in turn, will desire to receive. While the broadcasting of music has been the first phase of the radio boom to attract attention, the transmission of the spoken word in addresses, sermons, and lectures will eventually be one of the most popular and best appreciated functions of the broadcasting stations. Universities, churches, and state and Federal governments will, it seems obvious, find the broadcasting of news, talks, and information an increasingly vital factor in their service to the public, while I believe the public will ultimately find the greatest interest in just such material.

The wildfire spread of radio has, of course, been much more amazing than any other thing we have seen in our time. One is at a loss in trying to think of any phenomenon to which it can be compared. There are moments in history when the normal course of economic progress is sud-

What Next in Radio?

HERBERT HOOVER, Secretary of Commerce and probable radio dictator of the United States, answers in this statement the questions about broadcasting that are being asked more frequently than any others this summer.

Everybody who has invested in a radio receiving outfit—or expects to—is wondering just how large and lasting his dividends in entertainment will be.

Secretary Hoover—even now the most important government official concerned with wireless—will become, in effect, supreme ruler of our radio destinies if recommendations of the Washington conference are carried out. His statement for **POPULAR SCIENCE MONTHLY** may be considered, therefore, to have unique authority.

dently intensified, and for a time we live in a veritable furnace of revolutionary activity, from which we emerge with a new agency of civilization in our possession or a new industrial weapon at our command.

Apparently, we are in the midst of such a period now. We are all so closely involved in the radio expansion that it is futile to attempt to predict where it may lead us. Aside, however, from the intense enthusiasm which we must all feel for its future, even if we cannot visualize that future, we may say at once that the tremendous speeding up of activity in all establishments connected with the manufacture and sale of radio apparatus has been a contribution to economic revival.

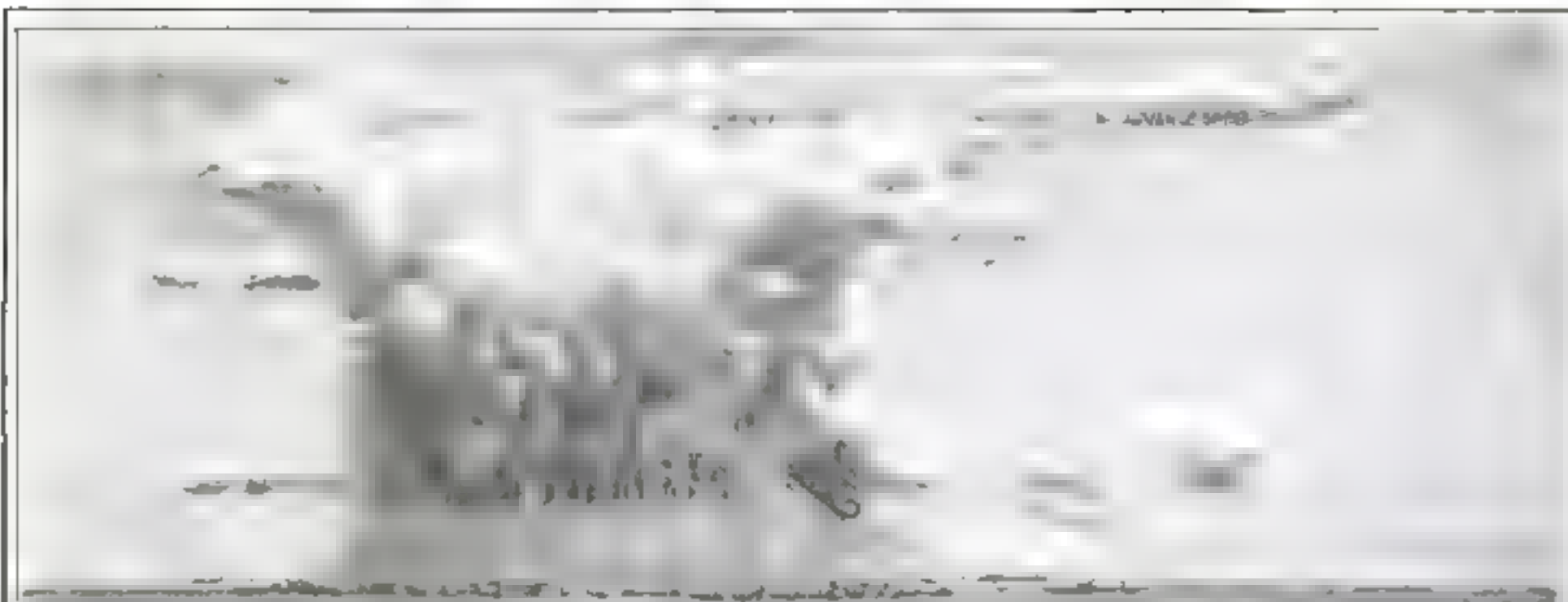
We know, of course, that the spectacle we see today has been in preparation behind the scenes for many years in the laboratories of great inventors and of enterprising manufacturing establishments; yet, coming at the moment it does, building

up almost overnight an enormous new economic activity, the growth of domestic radio seems almost providential. While the era of slackened business was still painfully with us, and while the opinion was general that people did not have money to spend, this marvel developed, stirring the popular imagination and inducing the spending of money for radio apparatus literally by millions of dollars.

Perhaps, when it is all over, and we can look back at the event, we shall see that this fascinating new national utility, springing up abruptly outside the existing frame of industrial life, arousing public enthusiasm and stimulating increased buying, was one of the important factors in bringing commercial activity back toward normal.

Meanwhile, questions as to the future home uses of radio are inevitably ever present in our minds. It seems not unreasonable to believe that in the long run much of that future lies with government and public broadcasting. We are witnessing, indeed, the dawn of a new day in communication. It is a dawn glowing with the promise of profound influence on public education and public welfare.

Colleges, churches, educational and lecture foundations, and government departments will almost certainly find in the future that radio broadcasting has become a vital part of their work. The home in which a radio set is being installed may confidently look forward to the receipt from the air of an ever increasing quantity of important and interesting information from many sources that have never before been so accessible to the American public.



A TYPICAL thunder storm, showing the air disturbances that occur in its path. From the front of the storm, which is moving toward the right, warm air from the earth's surface ascends through the cloud, while air cooled above or within the storm itself rushes downward, causing cool winds to flow out on all sides. These wind gusts are strongest at the front of the

storm because the forward movement is added to their velocity. Along the front, tumbling between the rising and descending currents, there is often a "squall cloud" that brings the first heavy dash of rainfall. Topping all is a high cloud sheet over flowing from the thunderheads and extending forward, sometimes for miles. These clouds form the storm's "advance guard."

The Secrets of Death-Dealing Storms

Science Explains Cloudburst, Tornado, and Thunder Shower

WHO has stood fascinated by the spectacular approach of a menacingly black thunder cloud, waiting for the summer storm to loose its fury, without wondering where it came from, how it was formed, and where it accumulated its store of energy that suddenly beats down upon the earth in the form of raindrops, hailstones, or whirls of wind?

The thunder storm, hail storm, cloudburst, and "twister," that often sweep paths of death and destruction during the summer months, seemed mysterious acts of supernatural vengeance until the scientific explorer began to learn their secrets and to trace their origin. Then he discovered that they originate where they end—at the surface of the earth. The sun warms the earth, which in turn heats the lower air. This warm, moist air, because it is lighter than the air above, rises in currents. Ascending, it expands as the pressure of the surrounding air diminishes, and cools into water vapor that accumulates in clouds and floats in the air like fog, buoyed up by rising air currents beneath.

The Storm Clouds

In this manner are formed the storm clouds, of strange shapes and shades, that under certain conditions of temperature and moisture assail us with hailstones, rain by the "bucketfuls," or whirling winds.

At the beginning of the nineteenth century practically

nothing was known about the origin, characteristics, or movements of storms. In fact, practically all our knowledge about

them has been unfolded during the past 50 years. This knowledge has come after long, painstaking study; for the meteorologist has been unable to reproduce storms in the laboratory for experimental purposes. He must study them as they occur or as they have been recorded.

Most people are familiar with hailstorms that cause great damage to growing crops. Probably many readers have seen hailstones as large as hens' eggs. But probably few of us would believe that hail could fall in sufficient quantities to delay railroad trains, or in stones of sufficient size to kill cattle.

Yet such was the case at Gray, Iowa, during the night of Aug. 7 and 8, 1888, when the drifted hail covered fence posts and held up trains, and when 26 head of cattle were killed. Some of the larger hailstones measured 18 inches in circumference.

How Hail Forms

Hailstorms are simply thunderstorms in which the vertical air currents within the storm cloud are of unusual magnitude. Hail falls only in connection with thunder storms. But comparatively few thunder storms precipitate hail.

Hailstones are formed when raindrops are carried by the vertical currents up into the region of freezing temperatures. As soon as the frozen drops drift out of the area of strong updraft, they fall back into the region of liquid drops, where they become coated with a thin film of water. But



Here is a remarkable photograph of a Nebraska tornado at close range. An eyewitness says: "From the base of what appeared to be an ordinary storm cloud this funnel-like 'twister' began to taper downward in a long streamer, finally reaching the earth. The progress of the lower part was slower than that of the upper so that when the streamer was elongated to about 1½ miles, it parted at the center. The lower part continued on its course

they are again caught in the updraft and again carried into the region of snow and ice, where the new coating is congealed. This may happen several times, producing hailstones of various sizes and structure. Finally, however, they become too large to be sustained by the ascending currents whereupon they fall to earth.

Sometimes the hailstones, when broken through the center, show plainly the series of concentric shells about a small nucleus, formed in the manner described.

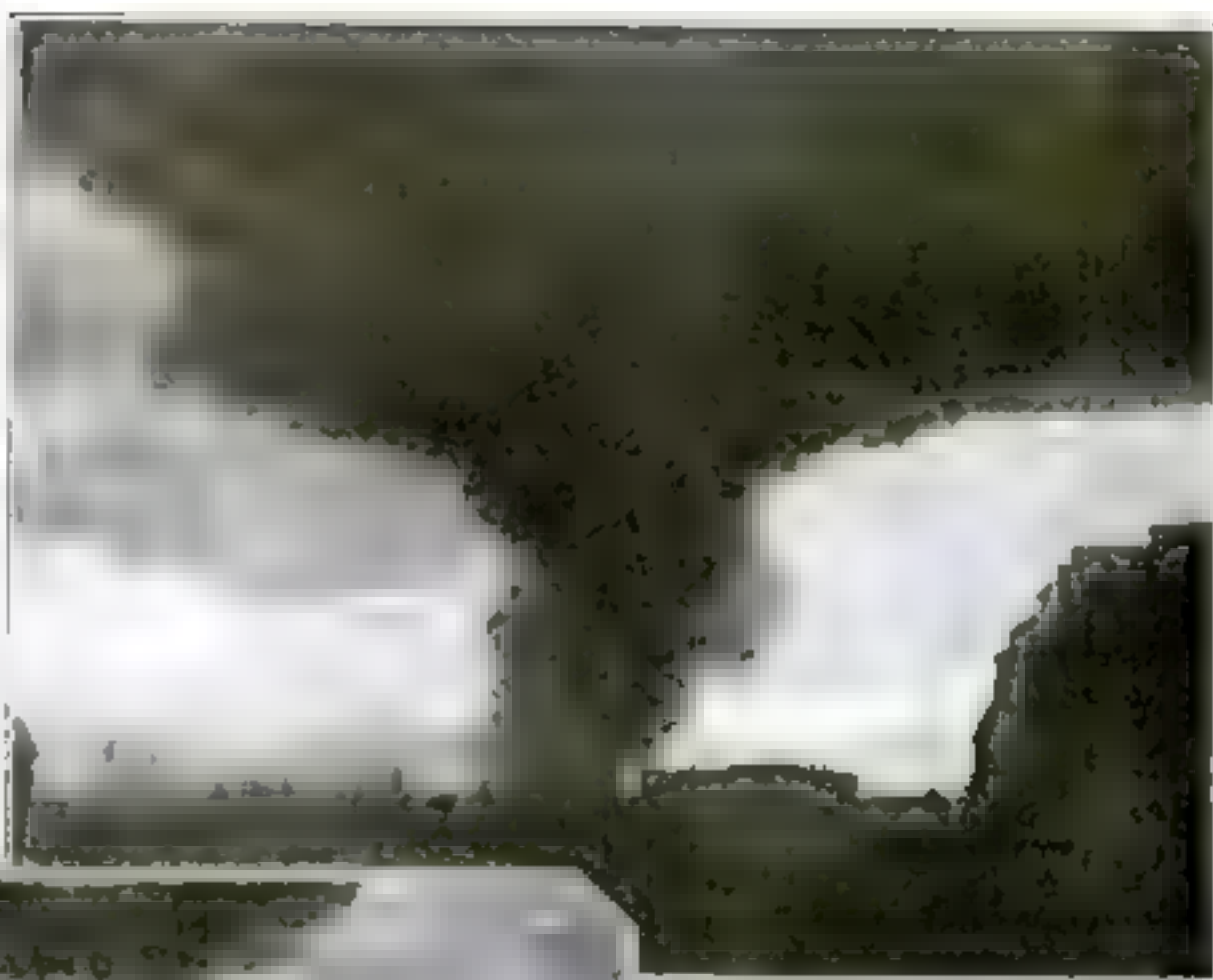
Why Thunder Storms Bring Hail

The reason that hail does not fall except in connection with thunder storms is that the vertical ascending and descending air currents that carry the raindrops up into the region of freezing temperatures are not present in other types of storms. The part of the thunder storm from which hail falls is near the front. Hail never falls except at the beginning of the storm. The reason is that the front is the only part of the storm in which ascending and descending currents exist. Owing to the small cloud area in which it is formed and the high speed at which the storm moves— from 30 to 40 miles an hour—the duration of the hail at a given location seldom exceeds a few minutes.

Sometimes the storm contains two separate areas from which hail falls, so that the damage occurs in two parallel but separate bands. This was the case in the remarkable hailstorm of July 18, 1788, which passed from Touraine, France, into Belgium, damaging crops to the extent of about \$5,000,000. The two bands were about 12 miles apart. One was about 10 miles wide and 420 miles long; the other, about five miles wide and 500 miles long.

Equally remarkable are some of the cloudbursts of history. Seven inches of rain fell in 90 minutes at Cambridge, Ohio, July 16, 1914, the greater part falling in 30 minutes. When we say "seven inches of rain," we mean that the amount of water falling was the same as the amount of water falling from a rain where it fell at the rate of one inch an hour for seven hours. A depth of rainfall of seven inches is equivalent to the amount of water a square foot of ground would hold, or about 800 pounds.

If you can imagine how fast that rain fell, you realize how the rain fell at Cambridge. Farmers who were working in the fields were



Above is another astounding photograph of an approaching tornado, taken at Antler, N. D., Aug. 20, 1911, from a distance of 1 1/2 miles. Such twisters are formed by violent upward air currents in a cloud which form a cyclone or whirl within the cloud. The whirl rapidly extends downward like a wedge. The stronger the whirl, the lower the wedge extends. In the center a jet of air is blown



How a tornado causes a building to "explode." Air pressure inside the twister is reduced in the case pictured, to 9 pounds to the square inch, while inside the building pressure is normal at 15 pounds. This pressure of 6 pounds to the square inch pushes the walls outward.

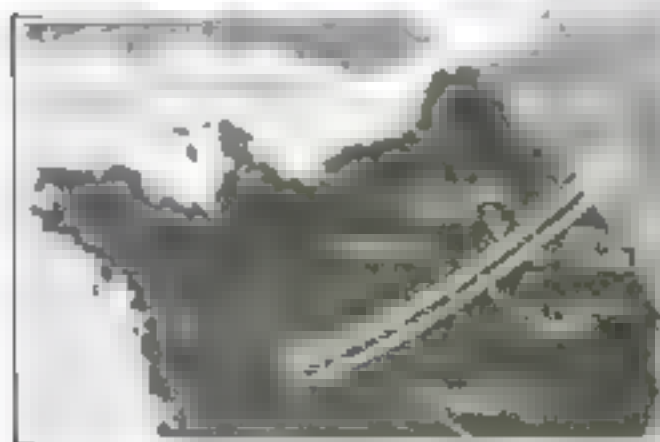
time said that they were greatly alarmed for fear that they would suffocate, and that the rain was falling so fast they had to hold their hands over their faces to breathe.

Engineers generally compare rates of rainfall by calculating the total depth of water that would fall in one hour if the rain continued at the same rate for that length of time. Thus in a cloudburst at Porto Bello, Panama, in May, 1908, rain fell at the rate of 30 inches an hour; that is, if the rain had continued for an hour, the total amount of water that fell would have equaled a depth of 2 1/2 feet on the ground. Such a depth would be equivalent to 100 pounds of water a square foot or about 3400 tons an acre.

Size of Drops Limited

Professor Humphreys, of the United States Weather Bureau, a recognized authority on meteorology, has determined that raindrops are never larger than a fifth of an inch in diameter, and that they fall through still air faster

than 26 feet a second. These limits are due to the resistance of the air. If a drop becomes larger than a fifth of an inch in diameter, the air friction on its surface becomes greater than the force of cohesion that holds the water together,



This map shows the paths of a remarkable hail storm that passed from Touraine, France, into Belgium in 1788. Hail fell from two separate storm clouds, advancing side by side. About \$5,000,000 damage was done to crops in two distinct parallel bands about 500 miles long.



The hailstone is built up in the way shown in the inset. It begins as a small drop that is carried upward by a rising warm air current, where it is coated with moisture. Then it is lifted by another rising warm air current, its water coating freezes, and it falls again. This process is repeated until the stone becomes too heavy to be borne upward, and it falls to earth. Inset shows how a hailstone is built up into these icy layers.



and consequently the drop breaks up into two or more smaller drops. Similarly, when the velocity at which it falls reaches 26 feet a second, the friction of the air on its surface, which is tending to keep it from falling, becomes equal to the force of gravity, which is pulling it down, and therefore it cannot attain any increased speed.

Eleven Drops in Cubic Foot

If it is assumed that in the Porto Bello cloudburst the raindrops were all of the maximum size, a simple arithmetical computation shows that there must have been 286 raindrops falling on each square foot of surface each second. If they were falling at the maximum possible speed, there would have been only 11 drops in each cubic foot of air at any instant. Considering the cloudburst in this way the unusual record does not seem impossible.

Think of the power that would be available if such a cloudburst could be harnessed! Thirty-four hundred tons of water falling in an hour from a height of a half a mile, which is about an average height for the lower surface of the clouds in such a storm, would represent 10,000 horsepower. This would be only for one acre; for one square mile the energy would be 5,400,000 horsepower.

Cloudbursts above Pueblo, Colo., June 8, 1921, resulted in a flood in which 120 lives were lost, and property throughout the valley was damaged to the extent of about \$20,000,000.

Cloudbursts are simply heat thunder storms in which the rainfall is unusually great. Heat thunder storms are those caused by the rising and cooling of large masses of warm, moist air, called convection currents. As the air rises, it gradually cools by expansion, soon reaching the dew point, whereupon condensation of moisture and the formation of a cumulus cloud, or thunder head, begin. As the air continues to rise and to cool, condensation continues and the cloud becomes larger and larger, finally becoming a thunder storm. The drops of water within the cloud also grow larger and larger until finally they become too large to be sustained by the upward currents, or drift out of the direct path of the rising air, whereupon precipitation begins.

Storms Grow as They Advance

Such thunder storms generally form on hot, sultry days, usually in the afternoon. As they move across the country they gradually increase in size, sometimes attaining a front of 200 miles and a depth of 40 miles in six or seven hours, which is about the average life of a thunder storm. The rates of rainfall are generally higher during the early life of the storm, when the cloud areas are comparatively small. The heaviest rainfall occurs near the front of the storm, at about the time hail falls.

One interesting but as yet unexplained fact in the movement of thunder storms is that they are unable to cross large rivers. In some cases this probably accounts for the rainfall reaching cloudburst proportions. The storm, reaching the river, is stopped and held stationary for a time, so that the unusually heavy rate of rainfall usually present near the front of the storm,

The cloudburst is simply a thunder storm in which the rainfall is unusually heavy. It is an often observed fact that thunder storms are unable to cross large rivers. Reaching a river, the storm is held stationary pouring its accumulated load of moisture in a deluge upon one spot for an unusually long time. The theory advanced for the checking of a storm at a river is based on the presence of a wall of comparatively cool air above the water, which prevents the rising of warm air currents to which the thunder storm owes its existence.

is continued over the same territory for a much longer time than usual. Sometimes large mountains cause the storms to stand still, thus creating cloudbursts.

One theory to account for the fact that thunder storms cannot cross large rivers is the presence of the comparatively cool air over the water. The thunder storm owes its existence to a huge mass of rising overheated air, fed in from the front and sides principally from the front. When the storm reaches a large river, it encounters a mass of much cooler air, so that its supply of heated air is very much diminished. This condition may be responsible for the storm stopping and dropping its accumulated load over one spot. Cloudbursts also occur when two or more storms moving in opposite directions come together and consequently remain stationary for a time so that the high rate of precipitation is continued over the same area.

History contains many references to storms in which various foreign objects, such as oranges, frogs, and fish, fell with the rain. References to showers of blood, or of sulphur, are particularly numerous. The so-called showers of blood were simply



A cumulus cloud is built up in hot weather when great volumes of moisture laden air heated at the earth's surface, stream rapidly upward cooling by expansion. Invisible water vapor becomes visible cloud. If the process continues far enough, the mass of cumulus becomes the thunder cloud.

storms in which dust having a reddish color is carried down with the rain in sufficient quantities to produce deluges of red rain.

Finally, precipitation, the foreign substances, originally come from the earth, just as did the rain, the only difference being that while water is evaporated directly into the atmosphere, the foreign substances are lifted only by whirlwinds, dust storms, tornadoes, or similar phenomena. Having been lifted into the upper air currents, they are carried along with the storm until vertical currents diminish to such an extent that they are no longer able to support the foreign matter.

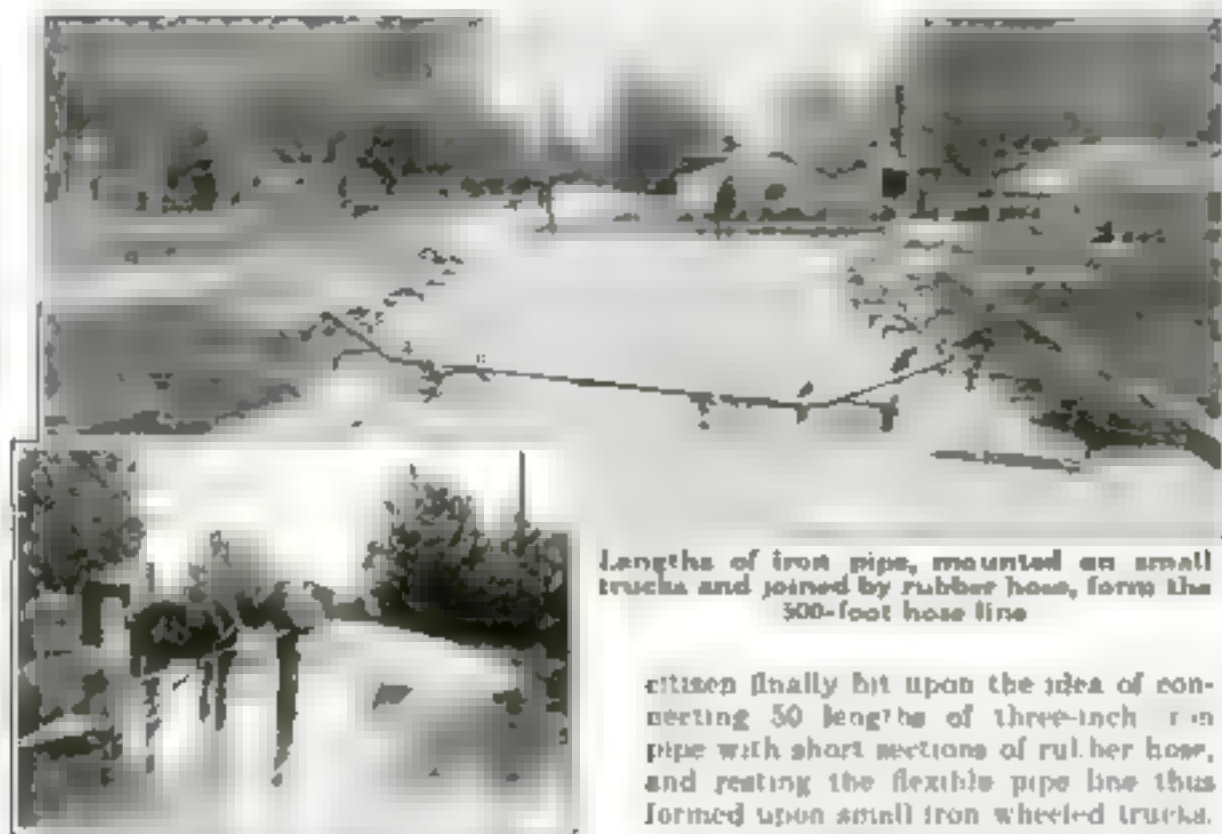
The tornado that is capable of lifting and carrying heavy substances appears to be caused by an unusually violent development of upward air movements in a cumulo-nimbus or storm cloud. This upward rushing of warm air, under certain conditions may become strong enough to form a whirl or eddy within the cloud. This air whirl, when once set up within the cloud, readily extends downward.

Whirling Air Creates Vacuum

The centrifugal force of the whirling air creates at the center a partial vacuum in which some of the moisture in the air condenses, forming a funnel-shaped cloud. And the stronger the whirl becomes, the lower the funnel cloud extends. Whenever it extends clear to the ground, the partial vacuum within the "twister" tends to destroy or pick up whatever may lie in its path.

Tornadoes have been known to make buildings "explode," to carry children a mile or more, lodging them, unhurt, in treetops, to drive straws into boards and to carry heavy stones high in the air.

One-Horse Hose on Wheels Washes Streets



Lengths of iron pipe, mounted on small trucks and joined by rubber hose, form the 500-foot hose line

WHOLESALE street washing on a retail scale has been achieved by the town authorities of Baker, Oregon, through the use of a strange pipe line on wheels, similar to the smaller pipes used abroad.

The town had water to spare, but the amount of hose required to reach some of the streets made street flushing an unwieldy proposition. An ingenious

citizen finally hit upon the idea of connecting 50 lengths of three-inch iron pipe with short sections of rubber hose, and resting the flexible pipe line thus formed upon small iron wheeled trucks.

The completed line is 500 feet long, but because of the rubber joints the water system can be quickly bent in any direction or even turned back upon itself. Motive power is supplied by a horse hitched to the front section of pipe. All the operator has to do is to direct the flushing nozzle.

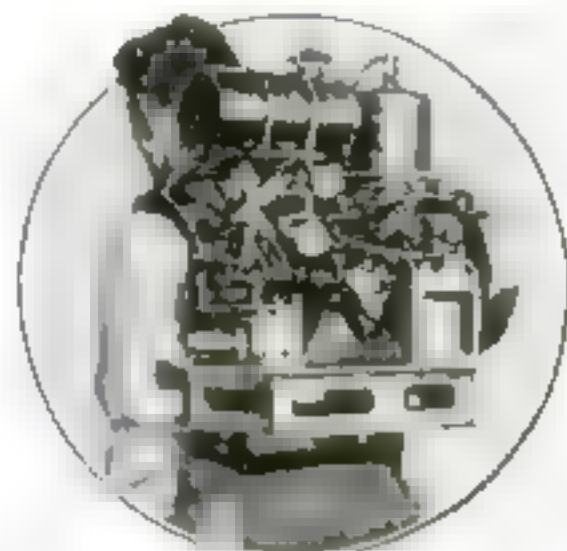
Portions of streets that are distant from hydrants may be reached easily by means of this pipe line.

Fire Fighting Pump Will Replace 50 Men

IN THE future, forest rangers in Minnesota will fight fires with new portable pumps light enough to be carried by one man instead of relying upon gunnysacks, picks, and shovels to open fire lanes.

The pump weighs less than 75 pounds, including a gasoline engine with its 8-quart tank filled with gasoline. Its capacity is 20 gallons of water a minute, and it will throw a stream 140 feet in the air.

Forest fires cannot be controlled with water, but the pump wets down the open



How the forest ranger carries the portable fire fighting pump

fire lanes and prevents the blaze from crossing them. It is estimated that one pump will take the place of 50 men using pick and shovel.



Camera Photographs by Its Own Illumination

TO FACILITATE the task of fingerprint experts in the detection of crime, George B. Bum, official photographer of the San Francisco Police Department, has devised a special camera that supplies the illumination at the same time that it is recording the view.

Near the front of the camera is a plug for connecting six small bulbs on the inside with the outside lighting source. These lights are located around the lens but not within its field. Thus a perfectly and uniformly lighted object is obtained a vital consideration in the photography of delicate lines such as fingerprints.

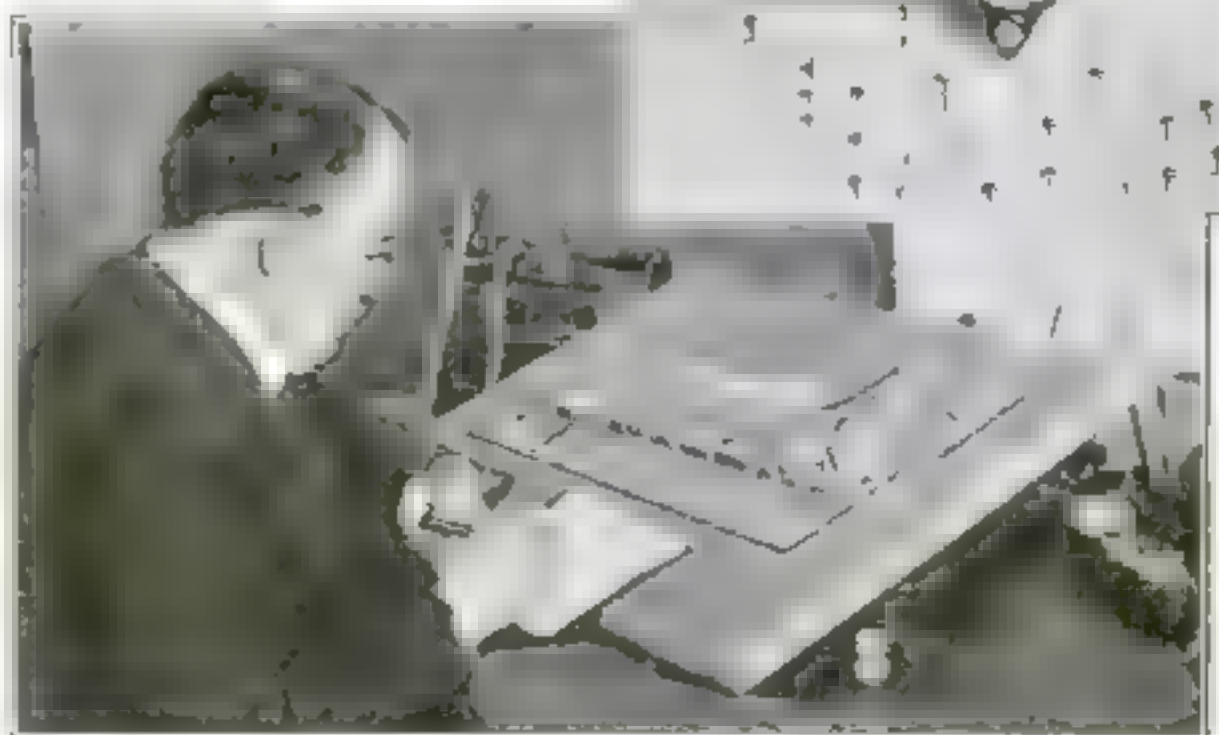
SEEDS from American trees are being sent to Europe to renew forests destroyed during the war. The American Forest Association has supplied 25,000,000 seeds from Pacific Coast trees to England alone. These include Douglas fir, Sitka spruce, and Western larch, which seem especially suited to climatic conditions there.

Map Measurer Saves Lost Motion in Factory

HOW many miles of travel can be saved yearly in a factory by a scientific rearrangement of the routes along which materials move? This is a question easily solved by Major Frank B. Gilbreth, efficiency expert, using a pocket map measurer.

In studying a problem of this sort, Major Gilbreth first makes a ground plan of the factory, with all machines in place and to correct scale. He then maps out the possible routes of materials from the beginning of the manufacturing process to the completed product. By traversing each route with the map measurer, he can indicate the shortest routing.

The map measurer consists of a marking wheel, which is made to travel along the routes, the exact distance being recorded on a dial calibrated in feet, meters, and miles.



On this exact model of the ground plan of a factory, lines are drawn denoting the routes along which materials might move. The wheel device shown in the inset moves along these lines, recording the distances.



How Power Will Set Men Free

My Ideal of City and Farm Made One

By Henry Ford

In an interview for POPULAR SCIENCE MONTHLY with Searle Hendee

HENRY FORD'S dream of America made over by a vast development of our water power resources is here presented in an interview by the writer who last month sketched for POPULAR SCIENCE MONTHLY readers a vivid picture of Henry Ford, the man.

Human health, happiness and prosperity will be achieved in fuller measure than ever before, Henry Ford believes, in the agricultural and industrial communities which he prophesies in this extraordinary article.



Plating Park Electric Light and Power Company in Colorado. The impulse bucket wheels at the right are twice as large compared with the mammoth modern Pelton wheels of the same type, which often weigh 25 tons.

THIS is the age of power. Electricity and gasoline are emancipating the human race from the slavery of primitive drudgery.

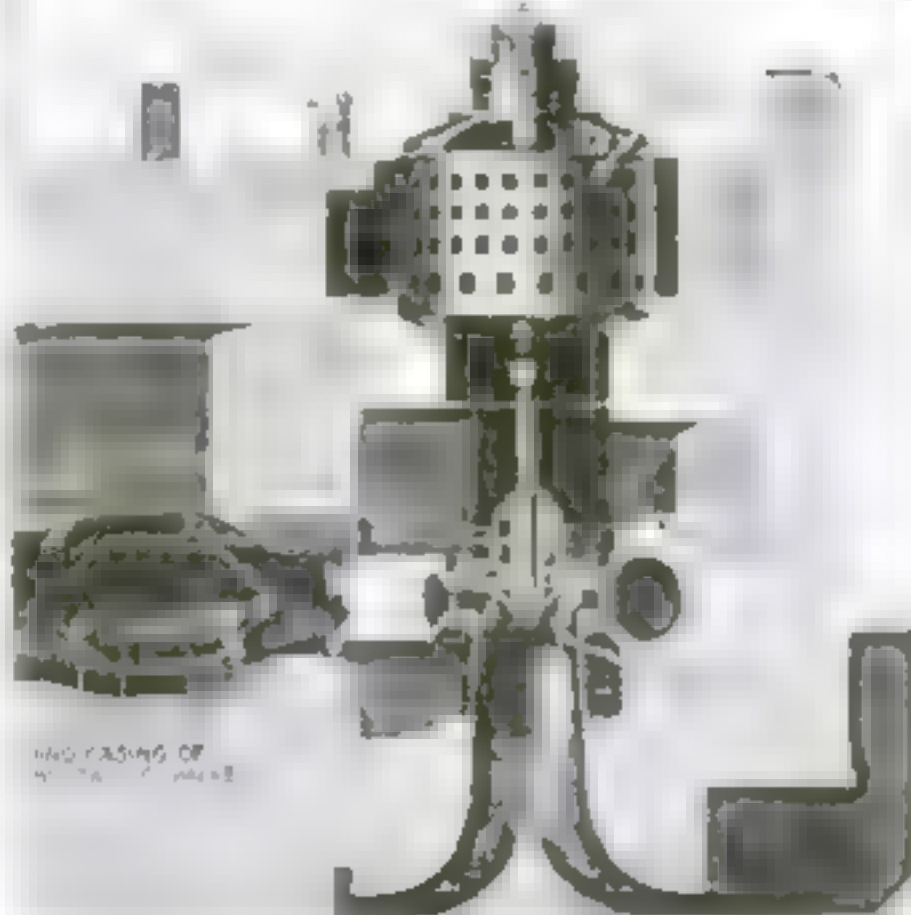
The America of 50 years hence is taking shape now. To visualize it, to picture the details of the civilization our children will live to see, it is necessary only to look about and see what's going on. People are growing more intelligent every year, yet it is surprising how few really know what is taking place on every side of them. Power is the key to tomorrow, just as yesterday it was the key to to-day. The only difference now is that we are speeding up—we are learning to make greater use of what we have.

We are in a period of transition. Whereas we have been grinding along with eyes focused in the ruts of obsolete methods, we are turning into the highway of greater intelligence. We are changing gears, and before long we shall be covering more ground with less fuss and effort.

Power the Answer

What has built every great metropolis of modern times? What has caused thousands upon thousands of young men and women to leave farms on which they were born and reared, to seek employment in our large cities? Why are boys and girls and men and women of the cities healthier, better read, more progressive, younger for their age, and as a whole more versatile than persons who have spent their lives on old-fashioned farms?

Power is the answer. Ready accessibility of power built our cities. It caused people to leave the drudgery of farm life and avail themselves of the advantages found in thickly populated centers. It has made machine production possible, and this in turn has brought shorter working hours and better working conditions. Since a day's work in the city has involved fewer hours, less physical effort, and has offered opportunity for broader use of the mind than has farm labor, the individual has benefitted



This giant descendant of the primitive hydroelectric plant shown in the upper right hand corner is in use at Niagara Falls. The huge turbine is capable of developing 55,000 horsepower from the impulse of falling waters and is designed to run at a speed of 187.5 revolutions a minute under a 305 foot head of water. Through the hydraulic valve at the left the water rushes in to whirl the blades of the turbine and drive the shaft, which is surmounted by the electric generator. After the water has given the use of its power, it escapes through a spreading tube into the tailrace at the right.

accordingly. Shorter working hours have meant more hours for personal improvement.

But manifold as are the advantages and attractions offered by the city, numerous also are its disadvantages and hardships. Centralization of power has caused centralization of industry. But this cannot be expanded indefinitely, and anything that cannot be expanded indefinitely is wrong. If you place working people in an unattractive environment, huddle them together in impossible tenements, crowd and pack them layer upon layer in cramped, stuffy, dingy streets, eventually you will get a kick-back.

One must remember when considering the human element that children cannot be excluded from the equation. It is true that

the city could be set a free from advantages at present denied children in many rural districts. And this is so true that

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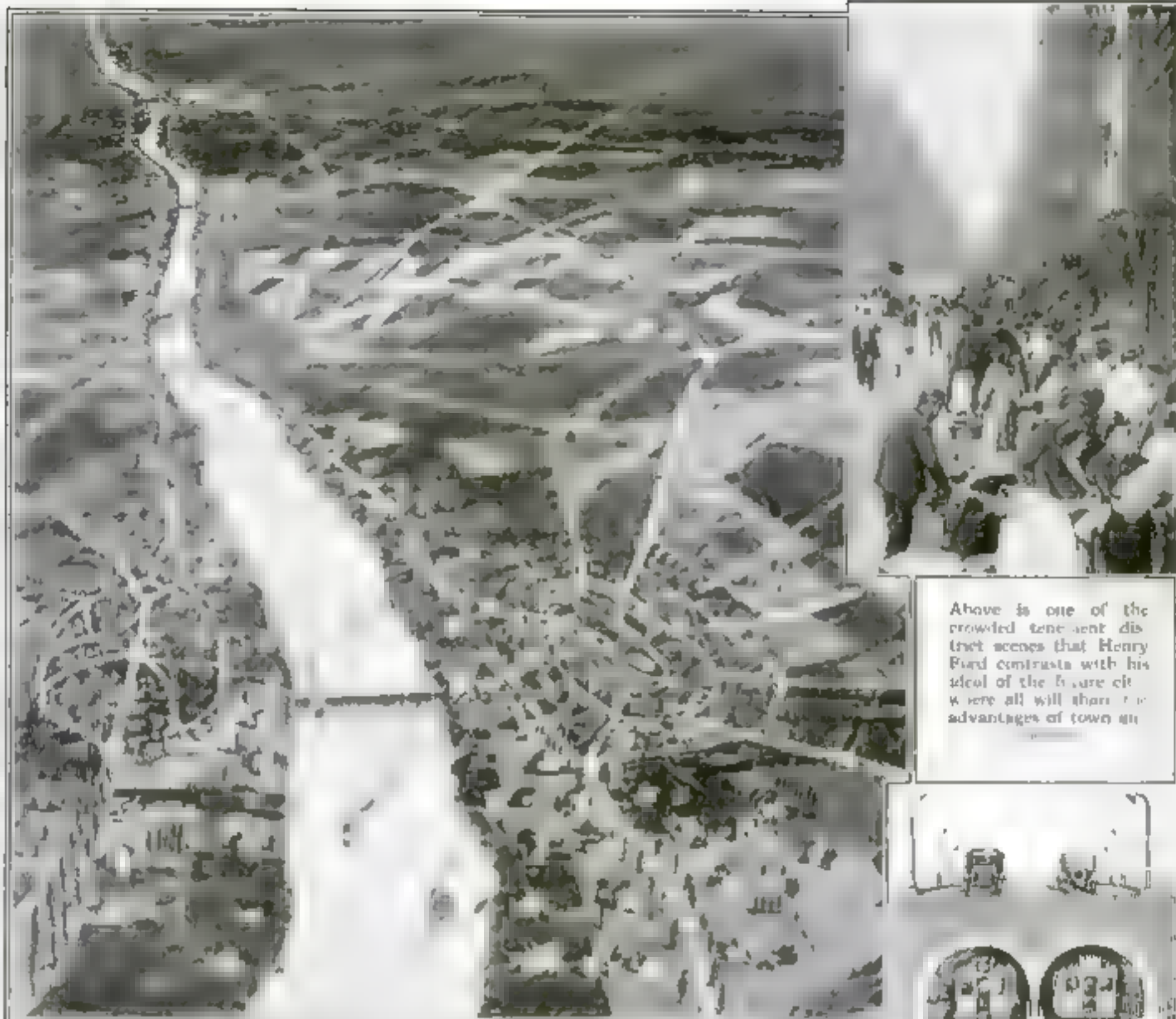
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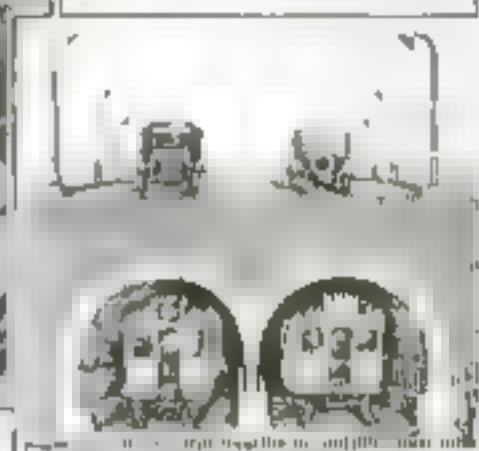
"City" of the Future

Our present system is not sufficiently flexible to meet satisfactorily the variable conditions presented by the human element. And therein lies the overwhelming disadvantage of the city. Expansion beyond a certain point results only in congestion, and this in its various phases lessens the values otherwise growing out of centralization.

Picture a community possessed of all the advantages and none of the disadvantages of the city, and you visualize the kind of place where American people are going to group themselves in the future. I contend that the light of modern developments shows that the trend is toward the semi-rural community. This in turn will be the "city" of the future. There is a basic need for it, it is logical



Above is one of the crowded tenement district scenes that Henry Ford contrasts with his ideal of the future city where all will share the advantages of town and



Is This to be the City of Tomorrow?

power is easily available for the...
...is available. A...

of water to supply power without waste for the factories and homes of the community. The inhabitant divides his time between agriculture and industry, devoting a few hours to each, and all the way to the river, intervening in the linking the communities on each side of the area are thoroughfares for surface and underground traffic as illustrated in the inset at the lower right.

and therefore it will be. For lack of a more descriptive name, we will call this coming "city" an agricultural-industrial village. It will be situated wherever natural power is available and the land tilable.

The reason for all this is almost too apparent to give in detail. First of all, the same thing that made the city what it is to-day, is beginning to make the farm what it should be. Power, in other words, is revolutionizing agriculture. To-day even farming may be made the most attractive and profitable business that is open to the aggressive individual possessed of an active mind. In the tractor, truck, automobile, and stationary gas engine; in power-driven appliances and electricity, we have the facilities that are making farming enjoyable, profitable, and worth while. Any thing possessing these three attributes is attractive to individuals endowed with imagination and energy. And therein lies the crux of the whole situation. By taking

power to the farm, we are abolishing its disadvantages and leaving all of its pleasant aspects intact.

But this is not the end. Power on the farm goes further than merely making agriculture a pleasant and lucrative occupation. It does more than shorten the farmer's working day. It enables him to accomplish everything on a general farm in about three weeks each year.

Farming in 21 Days

This is not theory—it is practice, on my 5000-acre farm at Dearborn. There is not a horse on the place. Tractors and power machinery do everything there is to be done—from plowing the soil to harvesting and transporting the crop—and they do it in 21 working days. For the balance of the year the rest of the work is left squarely up to Nature. We fall-plow while we are harvesting. That is, our plows usually

Follow the reapers. By the time the crop is off the ground, the job is cleaned up for the time being. A little later we put the tractors into the fields again and harrow and seed. Nothing could be simpler.

This in turn means something more. The city chap will want to turn to the farm. And since there is no profit in primitive drudgery, the reactionary type of farmer who endeavors to hold out against progress will be replaced by the youngster who can see ahead. The fact that there are still in America farmers who cut their grain with cradles, means nothing. There are thousands who are using reapers. And there are thousands more who know the value of the tractor because the automobile has blazed the way for it.

The tractor carries power of one kind to the farm. The small stream that winds through the fields brings still more power. And in the very near future this latter source of energy will be fully utilized.

Every farm blessed with a creek or river will have its own hydroelectric installation. I have nine dams across the little stream that passes through my property, and I develop between 400 and 600 horsepower. On the other hand, the stationary gas engine will solve the problem on farms where water power is not available.

It is not to be imagined that 11 months of idleness will characterize the life of the coming farmer. Here is where the rural industrial community comes in. The automobile makes it unnecessary for a man to live on his farm. He can reside in a pleasant village miles distant and have the comforts and advantages of the small city rather than the solitude of the farm. The "new farmer" will demand this. He will not live five miles from his nearest neighbor—he will live next door to him. This is only natural, because in a large percentage of cases he will be either directly or indirectly a product of the city and by nature will crave companionship and revolt against isolation. For the same reason he will require continuous employment.

Every creek and river afford a natural source of power. Along the banks of our innumerable streams will spring the rural industrial communities of tomorrow. Manufacturers will build their factories where power and labor await them, instead of hauling coal to city plants and exporting labor to seek them out and live under impossible conditions.

True, this is revolutionary—it is something to think about and reckon with. It will upset, to a degree, our present system. But it can be expanded indefinitely. Therefore it is economically sound and likewise inevitable. The man who isn't ready for it, the business that isn't prepared to adjust itself to it, had better get ready, for it is coming as surely as greater enlightenment, greater happiness, and a greater race are coming.

The Plan Works in Practice

The type of community to which I refer is not unknown at present. Here and there in various parts of the country, small factories and large are springing up along all sorts of streams, making use of water power and utilizing native labor. Only the beginning, of course, has been made. But the plan is right, because it works.

Take it in our own case. We have a number of small factories scattered around in little towns close by Detroit where water power is available and where we are now making parts for our cars and tractors. Over at Plymouth, for instance, all of the pistons for the Lincoln motor are made. And the workmanship is unusually good, too. I am not sure but that it shows the effect of the conditions under which the shopmen are living. At Northville we have another factory, and so on. At one point we make one thing, at another, another. We find the plan works out splendidly.

But whereas we have hydroelectric power—the best and cheapest power on earth—in our small plants, we burn coal at Highland Park. Coal is just about the most inefficient and expensive fuel there is. Anyway we find it so, and I doubt very much if there is any one in the country who is using coal more economically than we are. We utilize all of the by-products—even getting enough benzol out of it to pay for its transportation from the mines—cutting

corners wherever there are corners to cut, and yet at best it's expensive and unsatisfactory.

America's rivers offer enough power to turn every wheel, heat every room, and light every building and street in America. When this great source of power is properly utilized, coal will be as unnecessary as tallow candles. This being apparent, think now of what water power development will mean in the Mississippi Valley, beginning at the headwaters of the Mississippi and the rivers emptying into it, dams, hydroelectric installations, factories and prospering communities! And economically, what will be

"SOME people have too much and some too little, as a result of imperfections of our economic system. We need more even distribution. That is one reason why I indorse Henry Ford's water power idea so highly."—THOMAS A. EDISON.

the result? We shall make use of power that is now wasted, we shall conserve the human effort and expense now expended in the mining and transportation of coal; we shall automatically abolish the flood problem, thereby saving millions annually; and, furthermore, we shall raise the standard of life while meeting the problem of living and lowering the cost of it.

The United States is a network of rivers and small streams, all of which offer us the most vital thing in modern life—power. The Mississippi alone is sufficient to guarantee the future of the United States.

It is not to be expected that the individual installations will be projects of tremendous size. The contrary will more generally be the rule. And it is because of this that industrial communities will follow the shorelines. First of all, huge developments—such as the Keokuk project on the Mississippi—represent too much waste. The loss of power in long-distance transmission is tremendous. It is more economical to utilize the current near the place where it is developed. Secondly, if you have facilities for developing three or four times as much power as you can possibly use within a given radius, your overhead immediately becomes ruinous.

In developing the Mississippi, it would be practical to construct a dam for about every 16-foot fall. This would give a long series of dams of moderate head which would pass the full flow of water every 24 hours without waste, for use would be found for all the power thus generated. It seems to me that this is about the way it will eventually work out.

Tractors Increase Production

To return to the tools of progress: Of all modern machines, the tractor is one of the greatest mechanical blessings that has been devised for mankind. Not only does it enable more work to be done in less time and at far less expense than heretofore, but it makes possible better work. Fields cultivated by tractor-drawn plows produce more than fields turned by horse-drawn ones, just as the latter increased the productivity of the land when it succeeded the crude wooden plow of more primitive days. Tractors make deeper plowing and subsoiling possible. This in turn enables the ground to give up the best that is in it, and renew itself, instead of gradually wearing out.

At our plant we are just getting ready to make tractors. Up to this time we have been experimenting and developing. There are not more than perhaps 300,000 tractors on American farms to-day. Millions of them are needed—so we are getting ready to manufacture.

Motor cars will be used even more universally in the future, because changing conditions are making them more indispensable. Also one must not forget that motor-trucking, now in its infancy, will hasten the changes that are coming.

So far as the so-called fuel situation is concerned, we have always had our calamity howlers. We shall have gasoline as long as we need it. It is true that we are getting poorer grades now than we did some years ago, but what difference does that make? Motor cars are getting more miles to the gallon today than ever before. In other words, we have improved the internal-combustion engine and are able to use poorer grades of fuel without difficulty. But we have not gone as far in this direction as it is humanly possible to go. From year to year we shall continue to find ways of improving and refining our motors so that they can accommodate the fuel that is at our disposal.

But suppose, for the sake of argument, we should actually exhaust our oil resources, exhaust even our vast shale deposits. What then? Would motor cars and tractors cease to exist? Should we go back to breeding horses and oxen?

Enough Alcohol for All Needs

When we have need of alcohol for fuel purposes, it will be produced commercially in sufficient quantity to meet all requirements. There is enough alcohol in an acre of Michigan potatoes to plow the acre of ground that raises them for a hundred years! The "fuel problem" will take care of itself. It need be no source of worry now.

America is a vast storehouse of raw materials. So far we have neither scratched the surface of its resources nor caught other than a faint glimpse of its possibilities. On every hand opportunity awaits the use of power, brains, and human energy. We can make of America and ourselves what we will. We have everything with which to work, and our final result will be good regardless of how many years may be spent in attaining it.

Unemployment, poverty, and wasted lives are as unnecessary as the system that makes them possible. Any social order that is not self supporting, that continually has to be patched up, bolstered along and lifted over rough places by means of poorhouses, bread lines, relief work, and what not, has neither the right to exist nor the soundness with which to endure.

When we make power our slave and utilize it as fully as is possible in the light of present understanding, when we reduce the work of feeding and clothing ourselves to the simple formula that is within our grasp, we will enter upon a new and better plan of life—a plan that will not simply make for happiness and general welfare, but one that will enable us to develop ourselves intellectually and morally to a point more nearly in keeping with what should be. Individually we shall be better balanced men and women. We shall exercise alike our brains and our muscles. We shall be healthier, happier and of greater use to ourselves and those about us.

How a Broken Arm Made Inventor Wealthy

Tailor Hoffman's Luck Was to Fall Downstairs, and He Turned It into an Idea for a Steam Presser that Won Him a Fortune

By John Walker Harrington

WHEN young Adon Hoffman fell headlong down a dark stairway and broke his arm while employed as an apprentice in a little tailor shop at Syracuse, New York, he conceived the idea of a clothes-pressing machine that he could operate with his foot! That was an accident.

Developing his idea, by sheer determination, in the face of ridicule and discouragement, he finally perfected a steam machine that not only successfully replaced the clumsy hand-operated tailor's "goose," but cut in quarter the time and labor of pressing a suit of clothes. That was invention.

"Adon's Steam Arm"

Less than a score of years ago Hoffman's steam clothes press was rated as a freak. It was the source of gibes from his brother tailors. It was such an outlandish looking affair that they christened it "Adon's steam arm," and predicted it would meet a fate similar to that which befell Adon's real arm at the bottom of the stairway.

But today you see this same steam press, with the improvements of years, at work in the windows of tailor shops throughout the land. It has made its way to nearly every corner of the globe where clothes are worn. Since 1908, when it was first put on the market, 48,000 machines of all types have been manufactured and sold, and annual sales have increased from \$95,000 the first year to \$4,147,141 6. in 1921. That was good business!

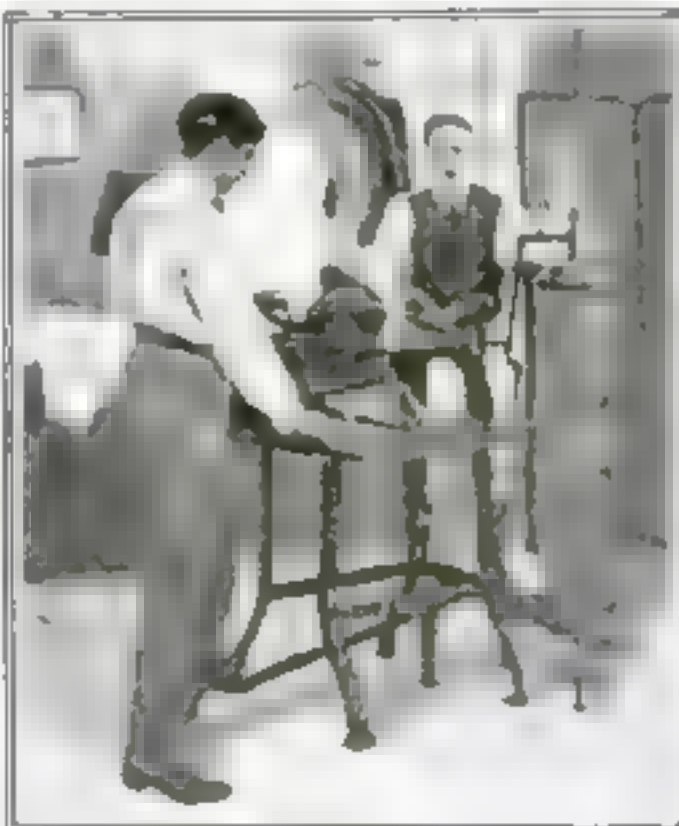
If successful invention consists of everlasting plugging in order to turn a chance idea to practical use, then Adoniram J. Hoffman may be called an ideal inventor. Today, in the prime of life, he possesses wealth, leisure, and the means of still greater endeavors in invention.

Hoffman was 18 years old when the accident that shattered his working arm convinced him that he could no longer wield the tailor's heavy iron, and that if he was to make a livelihood at his trade he must find a means of pressing clothes with his feet. At least, the idea was worth trying out. And Adon, born of sturdy New York farmer stock, tackled his problem with a determination that refused to be dampened by ridicule or apparent failure.

Before his arm was out of splints, he began to construct the strange machine piece by piece, substituting a board filled with steam for the heavy iron goose that more than one old-time tailor still pushes over the clothes of customers. He had little money to spend on patterns and

HOW many brilliant ideas have been lost, merely for lack of motive power to push them to practical use?

"The lucky dog!" we sometimes exclaim, when an inventor hits upon some valuable discovery and turns it into success. If you are inclined to believe that sheer luck or a chance idea is more than incidental in successful invention, read this story of an 18-year-old boy who was "lucky" enough to break an arm, who had a bright idea, and who turned this idea into wealth by grit and long hours of hard work.



"SAY, young man, what are you doing?" demanded the dismayed insurance agent, as he saw his best trousers disappearing into the jaws of a strange, steam-spitting contraption that resembled, to his perturbed vision, a hissing alligator.

The insurance man's amazement as he watched the primitive model work marked the beginning of success for Hoffman's "steam arm," for he became interested in raising capital to place the steam presser on the market.

models, but he saved all that he could out of his slender wages, and invested it in templates, gaspipes, cast-iron frames, and a small steam boiler. The more he worked on his steam clothes press, the more he felt that he was going to save a great deal of labor.

"If I hadn't been so exceedingly lazy," he remarked, recalling those early days, "I should never have got anywhere."

There is an early picture of the inventor which shows him without coat or waistcoat and wearing baggy trousers and a skimpy shirt. He is standing before his new press of which his own raiment seems in dire need—looking at it bashfully, for he was always opposed to having his pictures taken.

Toddlng night and day to perfect the design of his steam press, Hoffman finally broke down, and decided to go West for his

health. With him he took his creation, thinking he might induce Westerners to have their garments smoothed out with it. Even then he did not fully grasp the full possibilities of its application to the great clothing industry. In Seattle, where he worked for a while, he pressed a few suits, but the results of his revolutionary machine methods failed to cause any noticeable wave of enthusiasm. He decided that Syracuse

was a pretty good place, after all, and went back there, establishing a small clothes cleaning and dyeing shop.

Here the mud of Syracuse, chancing to spatter the trousers of a certain insurance agent, opened the way of new opportunity. In the office of a hotel in the upstate city sat Theodore Palmer, wet, dragged, a bit muddy, and tired, watching the New York Central trains as they steamed and splashed through one of the downtown streets. Finally, Mr. Palmer's eye rested on a sign in the window of a shop across the tracks, which bore the legend,

PANTS PRESSED HERE

WHILE YOU WAIT

"Why don't I?" he said to himself.

He waded over the swirling, muddy street to the little shop, where he met a tall, slight youth

The Beginning of Fortune

"I'd like 'em pressed," said Palmer.

"Take them off," replied the inventor.

Now this was hardly as impressive a greeting as Livingstone gave to Stanley, but it was the beginning of something brand new. In the discreet seclusion of a curtained alcove, Mr. Palmer divested himself of his breeches and settled down

to read a pink sporting paper devoted to heavy weight pugilists and burlesque queens.

Suddenly he was aware of a loud sizzling that strangely mingled with a pounding noise. Peering from behind the cretonne hangings, he saw his best trousers disappearing down the jaws of what, as nearly as he could observe, was a steam alligator.

"Say, young man, what are you doing with those?" he demanded. "I didn't tell you to can them, did I? What is that thing you are putting them in, anyway?"

Flinging about him the dressing gown provided for such emergencies, he entered the workroom and watched as Hoffman operated the first steam clothes press.

"Have you patented this machine?" asked Palmer.

"It is patented," returned Hoffman, pulling on a steaming trouser leg.

"Then why don't you do something with it?" insisted Palmer.

"Can't—haven't any money."

"How much do you want?" inquired the insurance man, drawing the Turkey red bathrobe around him and dropping the newspaper on a convenient chair.

"Fifteen thousand dollars would do," responded Hoffman. "Got it in your coat? I don't see it in these jeans."

"We'll get it right away," Palmer prom-

ised. It presses the garments slowly between two surfaces that resemble small ironing boards. By the operation of a treadle, the two boards are brought closely together and held by a powerful leverage with a pressure that may be regulated from an ounce to a ton. When the garment is

minutes. At this rate, if a tailor had a line of eager customers all day, he would have anywhere from \$30 to \$40 in his pocket by nightfall.

The steam press has been put to a wide variety of uses in the clothing industry. Special forms are used now for shaping the canvas linings of coats, pressing the collar, arranging the back seams, and in general giving the garments a spick and span appearance. Fully 65 of these special types of presses have been made for clothing factories in the manufacture of men's and women's garments, knit goods, hosiery, and underwear. In the large plants, the steam is drawn from one boiler, and there is a vacuum chamber that serves to draw in the water vapor from the damp cloth. Some large clothing factories operate as many as 200 of these machines. Hotels, steam laundries, and pressing and dyeing establishments also use the machine extensively.

Aids Other Inventors

Now that the inventor has made a fortune of his own, he enjoys assisting other struggling inventors in their enterprises, discussing with them their possibilities of success and giving them valuable advice. In Syracuse he is interested in a big industrial plant, a store, and also a butcher shop kept by an old schoolmate of his. He never has forgotten the friends of his youth.

When he is asked to talk of the secret of success for young men, Mr. Hoffman declines. He seems to prefer to lend a helping hand to the young inventor, assisting him along the road to success, rather than to talk about himself.

Electric Woodworker Can Do Fifteen Jobs

A NEW portable woodworking machine, electrically driven, is a combination saw and planing mill that will perform 15 different woodworking operations. Its capacity limit is hard wood two inches thick.

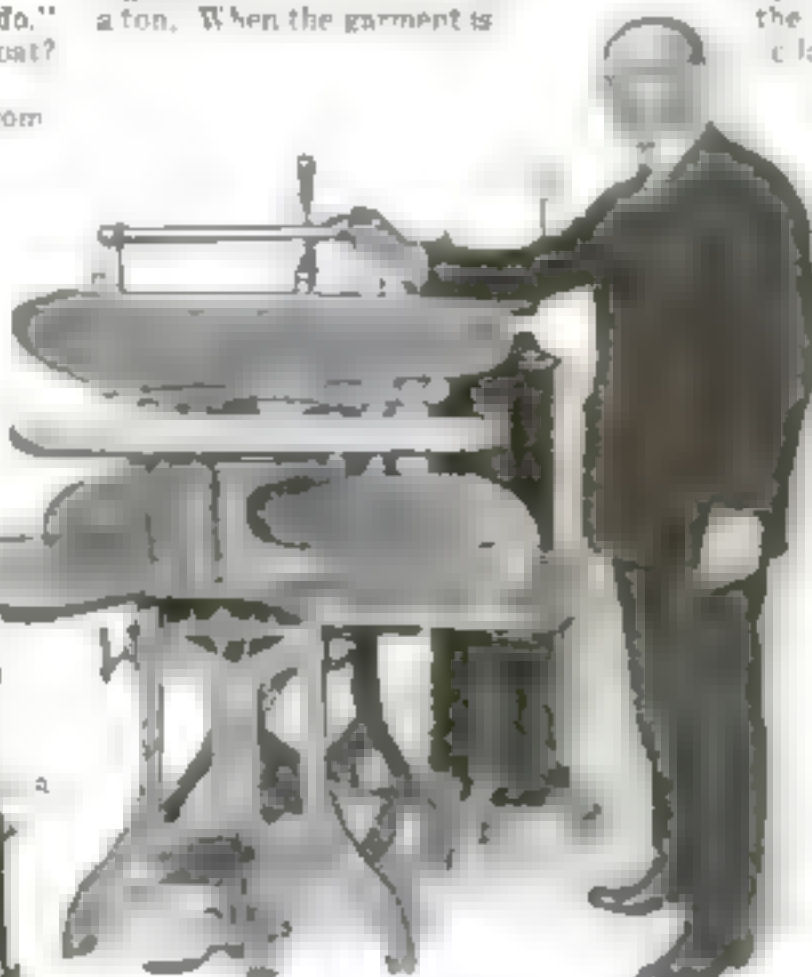
By a series of adjustable stops the carpenter can cross cut, rip, and miter as well



This combination saw and planing mill, electrically driven, is portable.

as do joinery. Tenons, dados, bevels, and plows may be turned out as fast as on the large size stationary machines. The new tool is light enough for a carpenter to carry in his car to a job, where it will work on any electric-light socket.

The operation of the steam presser is shown in the diagram below. While upper and lower 'bucks' or pressing boards, operated by a pedal, hold a garment under pressure, the opening of a valve sends a cloud of steam into them from the small boiler at the right. Another pedal operates a vacuum mechanism that sucks moisture from the garment.



Adolph Hoffman, the inventor, and the newest model of his steam presser. Since 1904 when with \$3000 capital he placed his first machine on the market, the company, which he founded, has made year and year increase of 45,000 presses, and sales have increased from \$9,000 the first year to \$1,473,000 in 1923. The company's business was built up entirely from reinvested profits. Today Hoffman pressing machines are used throughout the world.

ised, and was almost as good as his word.

Then and there began the marketing of the Hoffman invention on a large scale. The company was established in Syracuse with a capitalization of only \$3000, and the first steam press was placed on the market in 1903. That first year, machines were sold to the value of \$95,000. During each year that followed the sales climbed steadily, and the demand continued to increase. The original \$3000 was the only subscribed capital ever put into the business, which was built up entirely by the reinvestment of profits.

The Public Was Skeptical

At the outset, the inventor sold the appliance to a world that was skeptical. Palmer insisted that Hoffman go out "on the road" as chief sales agent, while he, Palmer, ran the factory and tried to get up financial steam. The work of placing the machine on the market was slow at the start, and for a time the only sales office was a small room adjoining the offices of the attorney of the company in Wall Street. The business expanded so rapidly, however, that before long Mr. Hoffman was relieved of the selling so that he could devote his time to further improvements. Several years ago he retired, having made a large fortune.

Numerous improvements have been made in details of the steam press, but the essential principles are the same in the crude original and in the highly specialized types of the present day. The device suggests somewhat the mangle of the old-time

laundries. It presses the garments slowly between two surfaces that resemble small ironing boards. By the operation of a treadle, the two boards are brought closely together and held by a powerful leverage with a pressure that may be regulated from an ounce to a ton. When the garment is in position between the boards, the turn of a valve pours a cloud of steam into the upper and the lower pressing surfaces, which are connected with pipes to a small boiler. The boiler is equipped with a powerful gas-burner, which roars like a Bunsen flame. The steam makes a continuous circuit when that effect is desired. There is an ingenious arrangement, however, worked by a small treadle, which creates a suction much like that attending the passage of a train through a tight tunnel. After the application of steam and pressure, this suction treadle operates to draw out all the air, steam, and moisture from the clothes. In almost less time than it takes to tell, the garment is perfectly dry, pressed to the proper shape. For pressing coats, there are heavy pads which can be placed in the sleeves to retain the proper shape.

The speed with which a suit of clothes can be pressed by the machine method varies from 15 to 20 minutes, according to the skill of the operator and the nature of the fabric. The tailor using goose or gas iron requires about one hour and a quarter to complete the same work, and even then the garments must hang for a while before they are dry enough to wear. Several hours, indeed, may elapse before the old-school tailor feels that his suit is ready for a journey into the world again. From 50 to 60 suits a day can be pressed by the Hoffman press, while only about 15 can be turned out by hand methods in the same period.

The highest speed record for pressing a suit of clothes by this machinery is eight

The A-B-C's of Electricity

A Simple Story of the Elementary Principles of the Most Mysterious Force Controlled by Man

"I consider this article on the elements of electricity not only well written and technically accurate, but one of an extremely worth while character, looked at from a broad point of view."—Dr. Charles P. Steinmetz.

THE tremendous interest in radio today has brought hundreds of thousands of persons into close contact with electricity as an important influence in their lives; for they have discovered that if they are fully to enjoy the benefits of this newest marvel of communication, they must understand its secrets a little more clearly than ever before.

Hitherto the mysterious, unseen energy that has given us the telephone, electric light, and street car has been handled for us by engineers; it has been made foolproof. With a button or plug we have made it our servant.

But successful use of a radio set requires a little more skill, a little more knowledge than the pressing of a button or the turning of a knob. It invites investigation and experimentation; and the layman, as soon as he takes up radio, discovers that the subject of electricity, which seemed forbiddingly difficult before, becomes a fascinating study. He can ride his wave of enthusiasm for radio straight into a better understanding of the elements of electricity than he ever had before. The lessons become easy and interesting.

Again, it is impossible for the average man to acquire a knowledge of the interesting ways of electricity from books alone. He

Protection of Radio Sets from Lightning

So many owners of radio outfits have inquired about the possible danger to their sets from lightning during the summer and the best means of protection, that POPULAR

SCIENCE MONTHLY put the questions up to Dr. Charles P. Steinmetz the world's authority on lightning. His answers, written especially for the benefit of radio beginners, follow.

By Dr. Charles P. Steinmetz

LIGHTNING presents potential danger to wireless sets and in all cases due precautions must be taken. The most inexpensive and practical one is grounding the set. If indoors, the ground can most effectively be connected with the city water pipes in the house. Assuming an outside aerial, care should be taken to ground it thoroughly by connecting the wire with metal plates and putting these several feet underground.

The technical reason for lightning's preference for jumping a short air gap—the simplest of lightning protectors—rather than passing through the set to the ground is found in the phenomenon known as electrical inductance. Lightning invariably chooses the shortest path to earth and the one of least resistance. In passing through wires, particularly wires containing coils, electricity encounters back pressure that impedes ready passage sets up. In other words, a counter effect that must be overcome. Rather than attempt to



Dr. Charles P. Steinmetz

overcome this, lightning, possessing a tremendous electrical pressure, prefers to pass across a gap of air, which it can readily do. The amount of energy in a thunderbolt, according to recent calculations, is estimated to average about 50,000,000 volts.

It is difficult to determine the limits within which a radio set may be operated safely before a thunderstorm becomes local in nature. This would be governed largely by the amount of static and other local conditions.

Will static ever be entirely eliminated? Possibly not, but I believe the annoyance that it now causes will be greatly lessened. I think that apparatus will be made to prevent static above a certain intensity from affecting the line. After that, what static comes through with the message itself may be filtered out by proper tuning. Since radio messages travel at some regular frequency and static has no frequency the solution looking toward its elimination will probably be the perfecting of some existing filtering process.



When you blow through a long tube, air pressure is diminished by friction on the sides of the tube, until it is far less at the end of the pipe

than at the mouth. Electrical resistance is similar. Current passing through a wire is impeded to a degree that depends on the size of wire.

must be using electrical apparatus daily. His radio set gives him, on a small but interesting scale, and in a limited but marvelous field, the opportunity to deal daily with electrical appliances. Theories of electrical conditions become clear to him, because he is dealing with practical applications of them.

Finally, since electricity is one of the greatest agencies for mankind's material welfare that has ever come under human control, we owe it to ourselves to know all we can about it. The great radio boom opens up the opportunity, then, for vast numbers of people to obtain an insight into a subject that has been a closed book to them. It will bring them nearer to an understanding of the achievements of electrical engineers and research laboratories.

Because it is hard for radio beginners to make headway through

the mass of textbooks and manuals at their disposal, an elementary statement of some of the A-B-C's of electricity may prove helpful.

None of us knows what electricity is. No man can isolate a portion of it and hold it up for others to touch, taste, or feel. But we do know how electricity acts, through long experience and experiments.

For a clear understanding of electricity there are three terms with which we should be acquainted at the outset. They are "volt," "ampere," and "ohm." Since electricity is considered as flowing through conducting substances just as water flows, the simplest method of describing the three terms is by comparison with the properties of water.

Consider a water system made up of a tank of water on a housetop, with a pipe leading to the ground. Now, if water is allowed to flow down the small pipe, it will leave the lower end with a certain pressure and in a certain volume. The volume is self evident, and the pressure can be noted if the finger is placed over the opening, as if to stop the flow. This pressure corresponds to the voltage in an electrical circuit, and the water volume corresponds to the electrical amperage.



Voltage in an electric circuit may be likened to pressure of water as it flows from a tank downward through a pipe. Just as the water flow increases as the tank is raised higher above the outlet, so the flow of electric current through a wire increases with the amount of voltage or pressure from the source.

If a larger pipe is then used for the water flow, the volume of water will be increased, but the pressure to the square inch will remain the same, because the height of the water tank has not been changed. On the other hand, let us suppose that the size of the pipe is decreased until the opening is very small. Neither the pressure nor the volume will then be great. The pressure should be the same, but the friction of the water on the sides of the pipe has taken away some of the pressure energy. The effect is the same as if a large crowd of people were pushing and plunging, in an attempt to pass through a narrow passageway. They become wedged into the opening, with the result that the number finally passing through the passage is considerably less than might go through if there were no crowding. The water leaving the large tank swirls through the small pipe, creating friction on all sides, but finally emerging as a trickle.

The resistance to flow on the part of the pipe is exactly the same as electrical resistance. Electric current, in attempting to pass through a wire, is impeded to a degree that depends on the kind of wire, its size and its length. Just as in a pipe line, where it is conceivable that the length of pipe would be so great that no water would reach the end, so in an electrical circuit a sufficient length of wire can prevent any trace of an electric current from passing through it.

Overcoming Resistance

But in the example cited above, even if the water is unable to fight its way through the pipe, all hope is not lost, for by increasing the pressure in the tank the water can be actually forced through the pipe, overcoming the resistance. Similarly, in electricity, the voltage must be raised, when it is desired to send a given current through a circuit having high resistance.

The unit of resistance is the "ohm," which is usually considered as the amount of resistance requiring one volt of pressure to force one ampere of current through a circuit.

Because it has always seemed so simple to use electricity by merely tapping into a plug connected with a seemingly inexhaustible supply of the energy, it is natural to form the idea that electricity has substance. An idea of how it can be handled in quantities is suggested by the storage battery, which is an essential part of the better type of radio receivers.

A storage battery must always be charged before it can be used. Charging consists of connecting the battery with a source of electrical energy, until all the energy the battery can hold has been taken in and absorbed. Let us assume that the battery has a capacity of four amperes of elec-

tricity flowing steadily for 15 hours, making 60 ampere hours altogether. If the same battery is connected with a small motor which consumes a current of four amperes, the motor can be run at full speed from the battery for 15 hours. (Of course, in actual

amperes, it can be operated for the full 60 hours before the electricity entirely runs out.

The storage battery and its electrical charge may be likened to a water tank that is not completely filled with water, but has an air space between the surface of the water and the top of the tank. Into this space, air under pressure is pumped. If this air is maintained constantly at the same pressure, the water that is forced out will flow with the same pressure, although the volume will vary according to the size of opening in the tank. There is a certain quantity of water in the tank, and this may all be taken out at once, or a small flow be permitted for a relatively long time. The storage battery, in the same way, is charged with a certain number of electrical units. All of them may be removed at once, or they may be allowed to flow out slowly for a long period.

"Induction" and "Capacity"

Next to the volt, ohm, and ampere, the two terms most frequently encountered by the wireless enthusiast are "induction" and "capacity." These words have a highly technical sound, and the amateur is prone to shy at them. The terms need be studied but little to be understood.

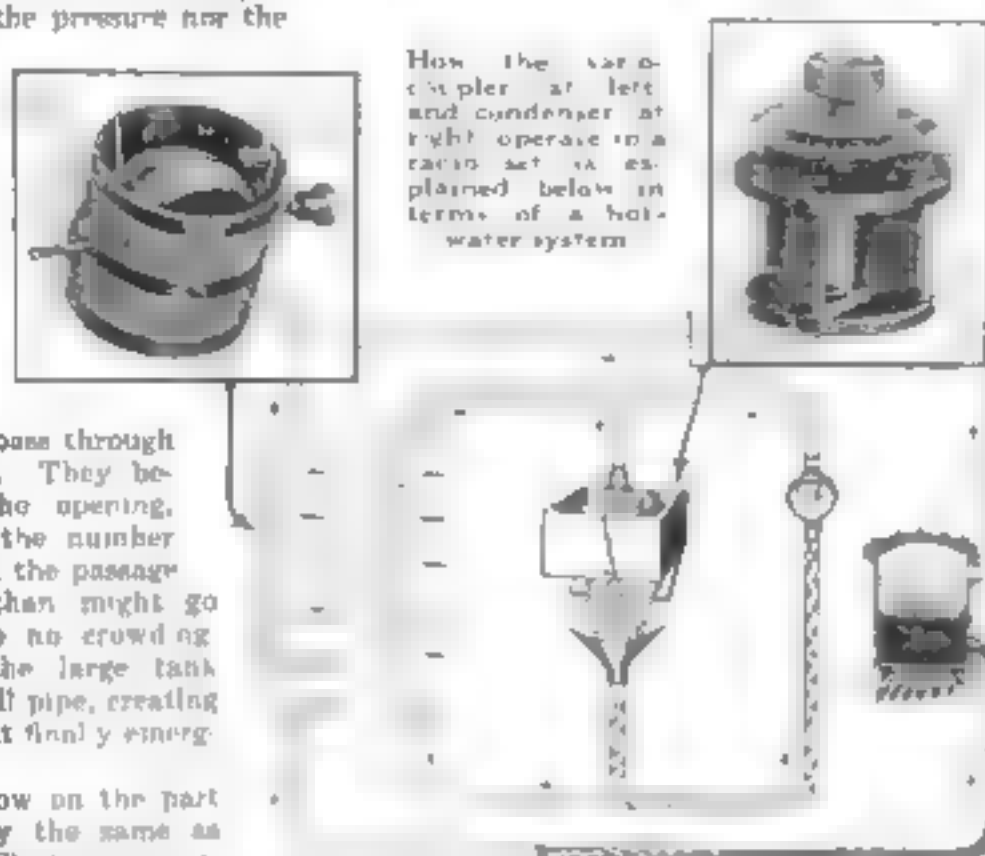
If hot liquid is passed through a copper pipe with thin walls, the heat will be transmitted to the outside of the pipe, and will then be dissipated into the surrounding air in the form of heat waves. Similarly, if an alternating current is sent through a copper wire, invisible waves of magnetism will emanate from the wire and gradually extend their radius until they are completely absorbed by the air. This radiation of magnetic waves is called "induction."

One of the best examples of the application of induction is found in the transformer so frequently seen on the poles of lighting companies. A transformer consists of two separate coils of wire, with a core of soft iron in each coil. When a current of electricity is sent through one of the coils, millions of these magnetic lines will be radiated.

The second coil, being placed near the first, will be affected by the magnetism, and currents of electricity will be started and maintained in the second coil.

Induction is personified by the tuning coil in radio outfits. Tuning coils, because of the form of their windings, produce the maximum value of induction for their purpose. Although the current in the radio waves, as picked up by the antenna, are exceedingly weak, they are strong enough to induce another current flow in the secondary of the tuning coil, whether it be of the loose coupler or the variocoupler type.

Loose coupler induction is not essential, as is proved by the fact the signals can be received with a simple tuner, having only one coil of wire, but currents induced from one coil to another make it possible to tune in one station and tune



STARTING with the heat generator at the right, follow the arrows indicating the flow of water through the pipes. When the hot water reaches the coils at the left of the diagram (corresponding to the primary coils of the variocoupler), heat waves dissipated from the pipe pass to similar coils corresponding to the variocoupler's secondary coils in a second water circuit. Here the heated water rises, passing to the tank shown in the center (corresponding to the radio condenser). When the volume of water reaches the limit of the tank's capacity it springs a trap that opens the hinged bottom of the tank, and rushes out in a sudden avalanche. As soon as the tank is emptied the door automatically closes and the tank fills again.

The condenser in a radio circuit operates like the water tank. Electric waves entering the circuit through the aerial pass by "induction" from the primary to the secondary coils of the variocoupler and into the condenser, where they pile up. When the condenser has all it can hold, it suddenly discharges all the stored up electrical energy in an avalanche. This operation is repeated hundreds of thousands of times a second.

practice the amount of electricity given out from the battery can never be quite as great as that put into it, but for purposes of comparison, this fact can be disregarded. If, on the other hand, the battery is connected with a motor that consumes only one

"Modern Jove" Tells of Thunderbolts

BENJAMIN FRANKLIN pulled lightning from the clouds; but Dr. Charles P. Steinmetz created lightning on earth. The "modern Jove" of the General Electric Company is supposed to have learned more scientific facts about lightning in the past few years than man had known in perhaps a million years before.

Terrorizing and fascinating mankind since the days of the cavemen, lightning has at last been made a subject of intensive research. What Doctor Steinmetz studying lightning and playing with his own homemade thunderbolts has recently discovered, he himself will disclose in a special article for POPULAR SCIENCE MONTHLY readers next month.

To Keep in Trim without Strenuous Exercise, Try a Massage



Massaging the left leg is combined with bending movements of the trunk

ON THE theory that body massage is a more effective health builder than the usual run of calisthenic exercises, Albrecht Hensen, of New York, has worked out a system of massage movements that has received the indorsement of some of the foremost physicians. No special apparatus is required.

The movements are carried out almost entirely with the fingers and the palms. The motion is similar to that of rubbing the skin, but its effect reaches the nerve layers and the inner organs.

It is claimed that these exercises improve the circulation of the blood and lymph, enrich the blood, burn away fatty tissues, build up muscles that are hidden away and seldom used, and revivify the nerves and glands, thus producing better health and an improved figure.

The most beneficial results are obtained, according to Mr. Hensen, by combining the massage movements with deep breathing exercises and with bodily exercises such as bending, stretching, and circulating



Movements for massaging the chest are combined with breathing exercises

movements of the arms, the bending of the trunk backward, forward, and to the side and bending and stretching the legs.

One Musician Becomes Whole Orchestra

A CONTROL device, invented by William J. Maxwell, of Brooklyn, New York, makes it possible for a person who has learned to play one instrument to play simultaneously any number of other instruments in harmony and rhythm. For example, the inventor, playing the banjo as the master instrument, at the same time plays the xylophone and orchestra bells. Ordinarily at least three musicians would be required to produce the same effect.

When the player of the master instrument strikes a chord, the secondary instruments accompany it with harmonious chords of their own particular type, either on the same octave, or an octave above or below, whichever is desired by the performer.



The inventor and his "orchestra"

The combination is made possible by electrical contact on the fingerboard of the master instrument, which mechanically works the other instruments.

Power Drill and Hammer Combined in One Tool

COMBINING a power drill and a hammer in a single tool, T. B. Payne, of Lincoln, Nebr., has invented a portable machine that will drill holes in steel, wood, or stone. The change from drill to hammer is accomplished by a quarter turn of the milled head just below the motor.

One universal electric motor of 1/8 horsepower supplies power for both opera-



Hammering and drilling holes in cement with the combination tool

tions. It turns at 10,000 revolutions, and is geared down to 1000 for drilling, and 2000 for the hammer. The chuck will take drills from 1/16 to 5/8 inch, bits up to one inch, and chisels from 3/4 inch for iron or steel to 1 1/2 inch for stone. The entire assembly can be taken apart readily for cleaning and repairing.



Drills, bits, and chisels that can be used with the machine

Make Money with Your Camera

YOU'RE missing lots of profitable fun this summer unless you have joined the growing army of POPULAR SCIENCE MONTHLY readers who are out with their cameras to win

\$50 *Three Prizes* **\$50**
 Each Month

These prizes are offered by POPULAR SCIENCE MONTHLY for the most interesting photographs of new inventions, mechanical and scientific achievements, or personal adventure.

The prize-winning pictures in POPULAR SCIENCE MONTHLY'S camera contest for July, appearing on other pages of this issue, are:

FIRST PRIZE, \$25—Sydney W. Green, Fresno, Calif. Subject—"Wire Cables Act as Bridge Girders" (see page 46).

SECOND PRIZE, \$15—Florence L. Clark, McGregor, Iowa. Subject—"Corn Fuel for Firing Brick Kilns" (see page 57).

THIRD PRIZE, \$10—J. R. Schmidt, Cincinnati, Ohio. Subject—"Fantastic Summer House Formed from Mud Pile" (see page 58).

Send in Your Photographs

And remember, if they are sufficiently newsworthy and interesting, they will be paid for at our regular rates, whether or not they win a prize

Coal Machines Make American Miners World Champions

UNCLE SAM is the world's champion coal miner, thanks to Yankee ingenuity in inventing machinery with which he is able to dig annually 100,000,000 tons of coal more than Great Britain's output and that with a quarter of a million fewer miners.

In the 30 years from 1890 to 1920 production of bituminous coal in the United States increased fivefold, while the output of anthracite doubled. The bituminous output for 1890 was 111,302,322 tons; in 1900, 212,316,112 tons; in 1910, 417,111,142 tons, and in 1920, 556,563,000 tons. A decrease to 406,990,000 tons in 1921 was due to unsettled industrial conditions.

The tremendous part played by time- and labor-saving machinery in filling the nation's coalbins is shown by comparison of figures for the average output of the underground worker. In 1901 when only one fourth of the bituminous coal production in this country was mined by machines, the average annual production of each miner was 729 tons. Eighteen years later, with machines mining 59.2 per cent of the total production, the individual's average output jumped to 1134 tons—the greatest output in the history of the world.

The old-time method of mining coal by pick is rapidly becoming a lost art. Less than 10 per cent of coal mined in Ohio in 1920 was taken out by pick method, more than 80 per cent of the output was mined by machines and the remainder by stripping methods.



Slow, arduous shoveling is supplanted by this portable loading conveyor. A scoop attached to the machine by a rope and pulled by a capstan, carries the coal to the mouth of the conveyor, where it is lifted into the mine.



Operated by a portable electric air compressor, this drill bores holes for the explosive that blasts the coal from roof and walls of the mine.

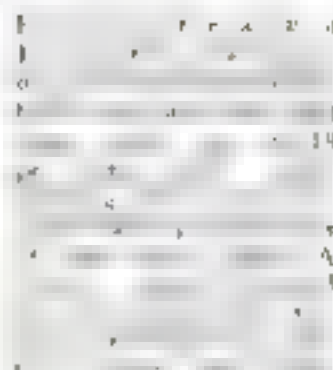
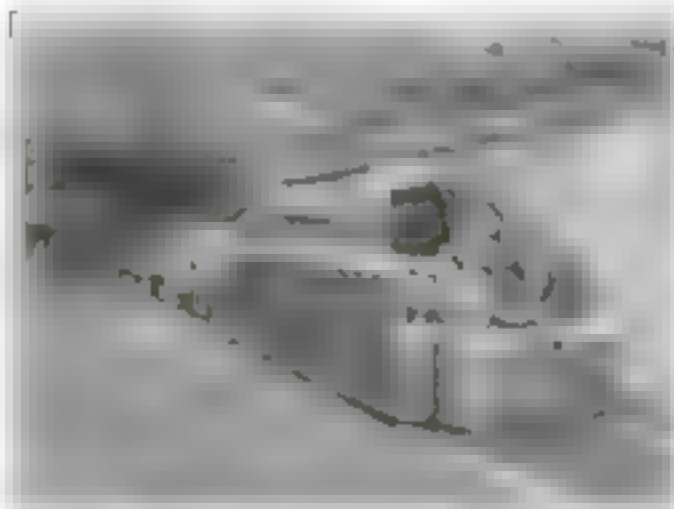


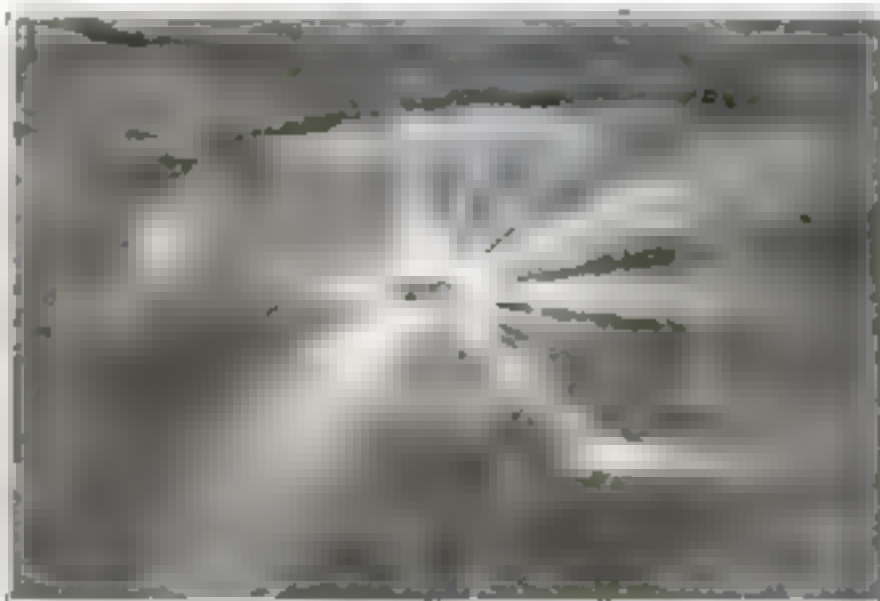
Illustration: Machine advancing the roadbed. When the bank reaches the height of the tracks, the machine advances to a new position under its own tractive power.



The slow-going mule has been replaced by this storage battery locomotive in hauling cars. Note the cleanliness of the modern coal mine tunnel.



Bits rotating at 240 revolutions a minute tear away coal loosened by "shots" and carry it to the loading conveyor. This machine can load 150 tons an hour.



This tank car sprayer, carrying water under high pressure, moves along the mine tunnel, shooting sprays in every direction and laying the dangerous mine dust.

Huge Pontoon to Raise Treasure Ships from Ocean Depths

SUNKEN ships with cargoes worth millions will be raised in 24 hours from depths as great as 350 feet—far beyond the reach of divers, if a gigantic pneumatic salvage machine invented by J. W. De Vito, of Boston, proves as effective in the full sized machine as tests with a model indicate.

The salvager is a colossal pneumatic pontoon that opens and shuts like a clam-shell dredge. When lowered over a sunken hull the great jaws close about the wreck. Water is then pumped from the air chambers of the pontoon, which rises to the surface bearing the wrecked vessel in its grip.

The invention may revolutionize salvage operations. At present, 90 feet is about the depth limit from which ships can be raised effectively. Thousands of vessels are lying with their sunken treas-



Guided by an inclined track, the pontoon sinks into position above a wreck, two hollow hulls close about the vessel, and the pontoon rises with its treasure

ures at a depth of about 300 feet. The fact that 15 of these wrecks contain \$635,410,000 in specie alone indicates the value of the treasure that may be recovered.

The completed machine will be as large as two full-sized ocean liners. Two hollow hulls, each 500 feet long, are connected by great joints at the bow and stern so that they can be opened wide

enough to enclose a ship. Triple hydraulic plungers force steel arms through the silt under the bottom of the wreck, and other plungers bring the parallel hulls together.

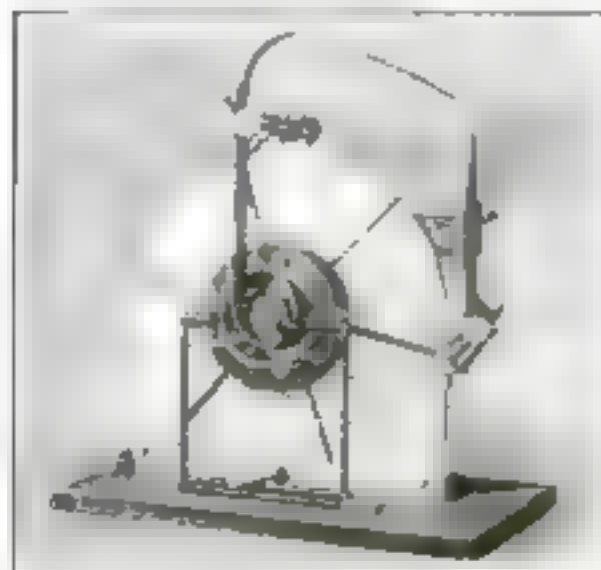
A pull of 17,000,000 pounds can be applied. Compressed air, admitted to the tanks, will give the salvager an effective lift of more than 50,000 tons. An inclined track, or guide column, directs the course of the salvager as it sinks into position over the wreck.

Theoretically and mathematically the machine appears to be practical, since the forces that can be applied seem adequate. Crushing of the pontoons is avoided by equalizing the pressure on the interior and exterior, either by means of wide open sea-cocks or the presence of compressed air.

Automatic Rewinder Feeds Film into Projector

HOW to recover a motion-picture film for a second run through a projection machine without rewinding has been a mechanical problem ever since the movies became popular. Now Charles F. Herm, of New York, claims to have invented a successful automatic rewinder that will fit into the space assigned to the rewind reel in the ordinary commercial projection machine.

The film is taken off a used reel, placed upon the rewinder, and the ends are then clipped together so that the entire film forms a loop. The beginning of the picture is on the inside of the film roll, which rests upon a roller bearing. As projection begins,



the bundle of film is rotated upon this bearing by a motor.

As the film turns over the stationary bearing, the strip winds on the outside, and the inside turns will be loosened. As fast as slack appears on the inside, however, it is taken up by a driving sprocket, which feeds the film into the projector. The result is continuous operation.



Red Lead Keeps Seeds Safe from Birds

WHEN the United States Forest Service began its work of reforestation, scattering tree seeds in woodlands thinned by lumbermen, so many seeds were eaten by birds and chipmunks that few trees sprouted.

But now the seeds are treated with red lead in a way that makes them inedible without detracting from their vitality. The seeds are spread on canvas strips and thoroughly mixed with finely divided red lead, which clings to them, so that animals and birds leave them alone.

Amateurs Can Engrave with New Electric Stamp

YOU can engrave your name in the barrel of your fountain pen by a new embossing stamp operated with electricity. It is so designed that a person of limited experience can cut the letters with no danger of cracking the pen.

The embossing stamps are set in the periphery of a disk, and heated by the electric current so that they melt the rub-



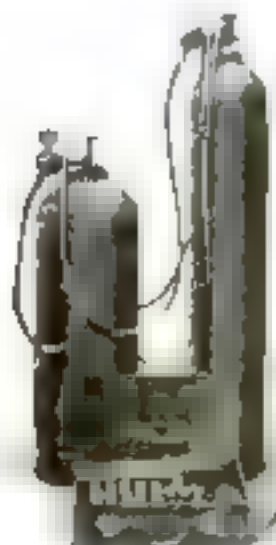
ber as it is brought into contact with them. A simple clamp, tightened by a thumb-screw, holds the pen firmly and moves it forward under the embossing wheel, spacing the letters perfectly. Any material affected by heat may be engraved with this machine.

As a special service to readers, the Editor will be glad to supply the names and addresses of manufacturers of devices mentioned in this issue.

Portable Welding Outfit Takes Little Space



A NEW and extremely compact welding outfit that may be carried wherever oxyacetylene gas is available permits the garage owner to use the equipment anywhere in his shop without sacrificing space.



The welding outfit and its case

perfectly gastight connection. The mixing chamber is in the head of the torch.

The entire outfit of torch, extension tubes, gas regulator, and hose connections fits in a case less than 15 inches square—slightly larger than the case of a folding typewriter.

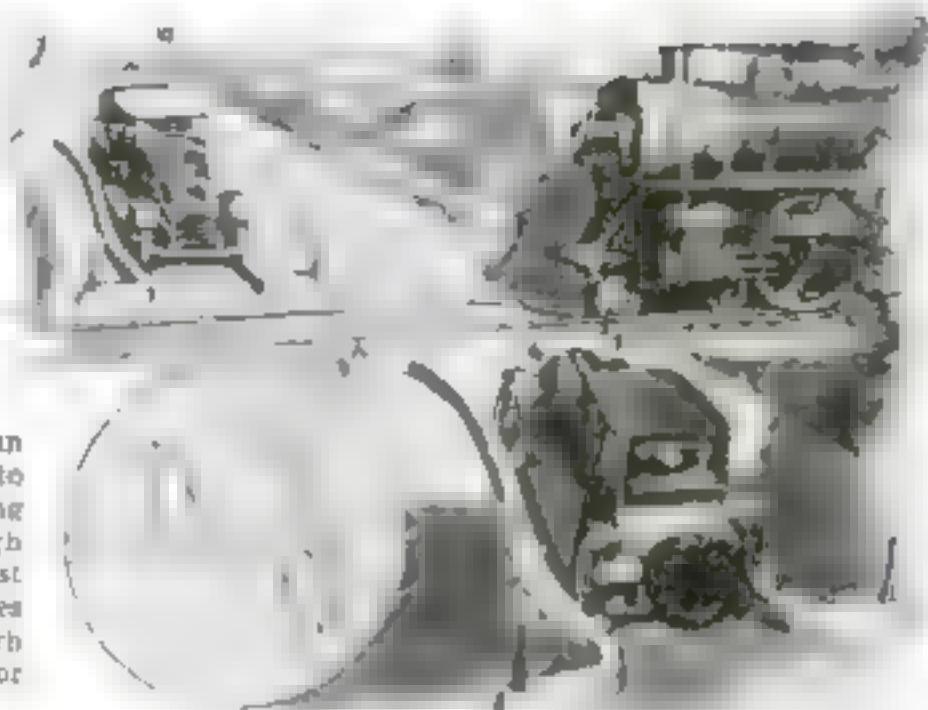
In the smaller sizes, the tips are of brass instead of copper, and are secured to the head by a fine-thread nut that is said to provide a

Speeders Curbed at Railroad Crossing

FOOLPROOF protective curbing that compel the careless driver to approach railroad tracks slowly have recently been invented by K. W. Carter, of San Antonio, Texas.

Instead of a gate, the approach to the crossing is guarded by curbing of concrete a foot or more in height, laid out so as to form a narrow, curving passageway through which the vehicle must pass. Extension pieces on the end of the curb make it impossible for the car to straddle it.

Drivers cannot go through this curving roadway at high speed, and so have no opportunity to take chances by rushing the gates or trying to beat a train to the crossing. Once across the



tracks, the road is unrestricted, since such a device is equivalent to narrowing the road, and the idea is to make the crossing safe with as little impediment as possible.



Windshield Gives Comfort on Deck of Bus

WINDSHIELDS on the upper deck of the city buses of Detroit, Mich., afford comfort to passengers traveling in the open air during chilly weather. The shield acts like the curved "dodgers" on the bridge of a torpedo boat destroyer, throwing the current of air over the heads of the passengers. The top seats are said to be nearly as warm as the interior. The shields can be removed with little difficulty for the hot weather.

Your Bicycle Can Generate Current for Lamp

YOU can make a dynamo of the front wheel of your bicycle, and light the head lamp with the current produced, by means of a new device that is rapidly becoming popular in Europe. A small electric generator is attached to the front fork, with a driving shaft ending in a rubber disk resting against the side of the front tire.

Friction is extremely light, and the cyclist, it is claimed, does not notice the resistance in pedaling, yet the current generated is more than sufficient to light a



Attached to the front fork, the tiny generator is driven by the tire

flashlight bulb. The more complete outfits include a tiny storage battery, so that a reserve of current is available to light the wheel when it is standing still. During the day the dynamo is thrown out of action by turning it upward on a pivot, thus moving the disk out of contact with the wheel.

Mechanical Smoker Tests Quality of Cigars

MECANICAL smokers that inhale four cigars at once are part of the testing equipment used by the cigar manufacturer to insure that your cigar shall burn evenly. The manner in which various kinds of tobacco will burn when they are actually being smoked, and the effect of various blends, are being tested in this way by David E. Brown, of the Department of Agriculture.

An air pump with an arrangement of valves produces intermittently a slight vacuum in a glass bottle to which the four cigars are attached, so that they are smoked in slow, gentle puffs. The time required to consume them is carefully



noted. If necessary, the products of combustion can be absorbed in the water bottle, and the cigar analyzed.

VEGETABLE fiber manufactured from a variety of grass grown in China is soon to be used to add life to woven fabrics. The fiber can be mixed with cotton, wool, or silk.

The Future Airliner

as Pictured by
Eddie Rickenbacker



Captain Eddie Rickenbacker, who sponsors the design

The commercial airliner of the future will probably resemble closely the airplane pictured here, especially if intended for supermarine travel, writes Captain Rickenbacker, first American ace during the war and now head of his own motor-car company.

"Radical as the design may seem, it will be observed that in its essentials—in cantilever wings, hull profile, retractable chassis—the airplane is simply an embodiment of engineering practices already sanctioned in America and abroad."

This superliner of the skies, for passenger and freight transportation, which Captain Rickenbacker predicts will be realized "with the passing of but a very few years," will be a giant monoplane, perhaps 300 feet from wing tip to wing tip.

The motors will be of approximately 1000 horsepower each, several motors to a unit and each unit driving a great propeller with three blades from 15 to 20 feet long. The motor units will be set in the wings, which will be very thick—from five to 10 feet on

the leading edge—and will be of internally braced cantilever construction.

The fuselage will be in the form of a boat but landing wheels that draw into the body during flight will also be provided. This will enable it to alight on land and water.



Top—Interior of the airliner, showing arrangement of cabins, staterooms, pilot house and observation deck in the nose.

Have You Considered Aviation as a Career?

By Glenn H. Curtiss

America's Foremost Airplane Manufacturer

WHERE are the young men who are going to make brilliant aerial careers for themselves in the next few years? Whom will be the names written large on the sky, in terms of fame and financial success, when the great boom of commercial flying comes?

Will you be among them? You may not realize how enticing a future aviation holds for the young fellow today looking about for an active,

adventurous career. But remember that while commercial flying has been suffering depression recently, just like all other businesses, the leading aeronautical companies expect an inevitable expansion within three years.

And when it comes, the greatest need will be, not for planes, routes, or landing fields, but for trained men. Boys now in high school and college will become the pilots and mechanics, and when the expanding industry requires executives and salesmen, they will be drawn from the practical fliers and mechanics, who know the business of aviation from the air down.



Glenn H. Curtiss

If you are looking about you for an occupation, the profession of aviation offers opportunities that seem almost unlimited.

Up to the present time most of the men employed by the commercial aircraft companies were aviators trained in the war; but war training is becoming less necessary and less desirable. At the front, the successful pilot was the man who took the most risks. If he broke his plane, the army gave him another. Because it was necessary to take many chances, a war-trained pilot has a tendency to believe that a certain amount of stunt flying is part of a good pilot's job.

The commercial companies think differently. Nowadays, a pilot who does reckless stunts is warned the first time and fired the second; for, above everything else, profitable operation demands men trained

to fly their machines safely—men who know that slight accidents that prevent a plane from going out on schedule cost money, and who are so thoroughly trained that they can avoid accidents and make the necessary repairs themselves.

Many of the war-trained pilots meet these qualifications, but many more do not, and the largest flying companies prefer to train their own men. Moreover, flying is a young man's game, and the former aviators are getting older. They are working in other professions, and however much they might like to do so, they are unlikely to return to aviation when the boom comes.

The man who decides to go into aviation today has his choice of more than 57 trades and professions which it embraces; but although an expert in any occupation from engineering to cabinet-making, from meteorology to bookkeeping, may find a job about a flying field, the profession of aviation divides itself into four main branches.

First there is manufacturing, both of planes and engines; second, operating by the pilots and mechanics; third, transportation, the selling of tickets and collection of air freight; and, finally, the executive, in charge of all. Just now, the chief shortage of men is in the transportation branch. Some of the most famous pilots

Grover C. Loening, a Big Name in Aviation at the Age of Thirty-Four

AT THE early age of 34, Grover C. Loening, America's most successful young airplane designer, is president of his own aircraft manufacturing company and was recently awarded the Collier trophy for the greatest achievement in aviation in 1921—the perfection of a monoplane air yacht approved by the Underwriters' Laboratories.

He is a graduate of Columbia and holds

the first degree ever awarded in this country for the technical study of flying.

Loening's career in aviation began as assistant to Orville Wright. Later he was Chief Aeronautical Engineer of the United States Army, where his experience and initiative enabled him to develop many new designs for war planes. He prepared the standard textbook on military aviation. Young Loening originated

the monoplane flying boat, invented the first rigid monoplane bracing, and introduced steel construction into airplanes in 1916.

Among the outward signs of his success is his recent election as first president of the newly formed Aeronautical Chamber of Commerce. He says:

"I do not see how any young man who decides to make aeronautics his life work can ever regret it."



Grover C. Loening and one of his flying boats



in the country—Roland Rolfs, for one—have become traffic managers, in charge of branch offices whose duty it is to sell airplanes and interest the public in airplane travel. But whatever line you may eventually decide upon, airplane operating is the essential groundwork.

As in any other business, a man must learn aviation thoroughly if he is to be successful in any one of its branches.

Aviation is still so young that even the highest executive must know how to fly a plane in order to manage the business and to interest other men in it. Here lies the opportunity for the young man of today. Many executives and salesmen will be needed before long. They will be drawn from among pilots and mechanics. The industry is growing so fast that there are practically no limits to what a person with the necessary preliminary technical training may accomplish when the expansion comes. The chances seem better than ever that the history of the automobile industry will be repeated upon a somewhat smaller scale. The mechanic of the early pioneer days will be the leader of the industry 15 or 20 years later.

Even after you have decided to learn to operate a plane, however, there are still two ways of going about it. At present, while the depression still exists in the manufacturing plants, probably the best way is to go to one of the good aviation schools maintained by commercial flying companies. The course lasts from three to four months, and at its completion the student is graduated with a pilot's flying license. The tuition is between \$350 and \$500.

These schools are modeled after the army training schools. The course is thorough and intensive. While the details vary under different instructors, the student usually spends the first two weeks in the motor shop, where he sees the engines as they are made, and learns to recognize the parts. The next two weeks are passed in the manufacturing shed, where he makes the parts of the wings and fuselage, learns how the plane is constructed, and becomes familiar with a complicated nomenclature. Beginning the second month, the student

goes to the motor assembly shop. Here he learns the assembly, makes block tests and trial runs, and becomes able to operate an engine at its greatest efficiency. From there he goes to the plane assembly shed, where he assembles the plane, learns to wire it, to true the wings and to make the important inspections that can be trusted to no one but the pilot.

The final week is spent with the shop inspector, and is a review of the preceding two

This Teacher Found His Fortune in Flying

WHEN Ralph C. Diggins, a young school teacher, decided in 1911 to learn to fly he spent six months and \$800 in a 'flying school' without getting off the ground. So he determined that the only way to fly at that time was to make his own machine and fly it. With the help of a friend he put together a conglomeration of wires, linen, wood and metal—and a motor, and after about three months' practice he finally was able to stay in the air about 10 minutes at one time without the motor going bad.

Those wild 10 minute flights led to exhibition contracts in 1912 and started him on a career in aviation. Today he is making money and success as one of America's foremost aviation instructors and active head of a successful aviation school in Chicago, which trained 73 students in 1921, with a record of 15,000 flights for a distance of 70,000 miles.

The same determination with which he built his first crude plane carried him through the pioneer days, through distinguished overseas service during the war, and now is responsible for the enlargement of his school, established in 1919, to train 250 young fliers this year.

His commercial flying activities today include an aerial photographic department. During the past year he and his students have taken at least 2000 aerial photographs.

Diggins' first commercial contract, on March 7, 1919, called for the delivery of a washing machine from Chicago to a home in Evanston, Ill. This is said to have been the first strictly commercial airplane flight in America.



Eddie Stinson Started in the "Gipsy" Game



TWENTY SIX hours, 19 minutes, and 35 seconds in the air!

That's the world's endurance record for aircraft, set by Eddie Stinson and his partner, Lloyd Bertaud, at Roosevelt

Field, Long Island, N. Y., on December 29, 1921.

Stinson's career as a commercial aviator is one striking example of the fame that a good pilot can achieve in cross country flying if he seizes the opportunities that are opening wider daily.

While he was still in his teens Stinson read all the information published on airplanes, and then persuaded a friend to buy him a plane. He was confident, he said, that he could fly it. Notwithstanding his native flying ability, he crashed. Then he entered an aviation school.

Before the war he was engaged in "gipsy flying," taking up passengers for short flights in his own plane. He entered the Aviation Service in 1917. As flying instructor, he trained hundreds of war pilots, chiefly at Kelly Field. His next job was test pilot for the J. L. Airplane Company and it was in one of their machines that he achieved the world's endurance record.

He writes: "The next generation will know as much about flying as we do about the automobile. Almost any one can learn to fly if he has confidence in himself and the hardiness to undertake the necessary training."

"EIGHTEEN years ago flying was classed with perpetual motion. Who, then, will attempt to predict what airplanes can do 18 years in the future?"

—Orville Wright.

months' work. This completes the ground school. During the evenings the student has been studying the theory of aviation. There is no spare time. A ground school is a very busy place, for the instructors assume that unless a student is far above the average both in quickness, alertness of mind and bodily strength, he has no business trying to become an aviator.

The flying course consists of from eight to 10 hours in the air daily, with an instructor, using dual control, in which the student handles the "joystick," with the instructor always at his elbow to take charge in case the novice starts to go into a tail-

spin or a nose dive. The finishing course is "solo" work, where the student flies alone, and learns to make landings and to handle his machine until he is able to pass the pilot's examination.

Although there is no national license bureau for airplane pilots, the large companies have their own standards, and

Curtiss Aeroplane and Motor Co.



Learning to fly, the student handles the controls with the instructor always at his elbow

"COMMERCIAL airplane service will become as much a part of our industrial life as railroad transportation is today."

—Glenn L. Martin.

maintain them rigidly. It is clear that under this system a man may become a pilot in from three to four months. His salary, when the demand for commercial fliers develops, may be expected to range from \$2500 to a maximum of \$6000, or, in exceptional cases, \$8000 a year. But a pilot's license will be the beginning, rather than the goal, of the successful aviator. It resembles a college degree. Though it means nothing in itself, it is a starting point for almost any position in the field.

Training is more important than wages during the first two years, for it should be emphasized that, in the

How Glenn H. Curtiss Won Financial Success in the Air

THE one outstanding financial success in American aviation is that of Glenn H. Curtiss, author of the above article.

Not so many years ago, he was a young bicycle repair man with only a public school education, received in his home town, Hammondsport, N. Y. But inventive and mechanical ability and grit were among his gifts. Later, he built motors and established the world's motorcycle speed record.

Today, he is the most brilliant living example of the subject he writes about in this issue of **POPULAR SCIENCE MONTHLY**—"Success in Aviation." Fame, fortune and leisure are his—all the result of hitching his career to the airplane, and hanging on.

The Boy Mechanic

Curtiss was born at Hammondsport May 21, 1878, with a fondness for mechanics and a love of speed—qualities that have grown with him, bringing him 21 prizes and medals and 67 patents. As a small boy he amazed grown-ups with his ingenious and often outlandish contrivances manufactured from old tomato cans, odd wires, and bits of machinery—in fact, he tried to make something out of nearly everything that came his way.

At the death of his father he became an apprentice with the Eastman Kodak Company at Rochester, N. Y. Here, while working with wood and small metal parts, he acquired a knowledge that aided him later in building motors and airplanes. During spare hours he earned extra cash for his experiments and a reputation for speed as a Western Union messenger and in this capacity he broke all records for speed in delivering messages. He is said to have been the first person to use roller skates and the bicycle for business purposes.

Returning later to Hammondsport, he worked in a small bicycle repair shop, of which he finally became part owner. Meanwhile he experimented with motors and produced a motorcycle that made him famous. Riding at Providence, R. I., in 1906, he established a world's record for

single cylinder motorcycles, covering a mile in 36 2/5 seconds. Then with an eight-cylinder cycle at Ormond Beach, Fla., he rode a mile in 26 2/5 seconds, or 137 miles an hour—a record never equalled.

To manufacture and sell Curtiss motorcycles the G. H. Curtiss Manufacturing Company was incorporated in 1905. Two years later Dr. Alexander Graham Bell, attracted by Curtiss' knowledge of aeronautical motor design, called him in as director of experiments for the Aerial Experiment Association. Here he conducted glider experiments, de-

veloped the first United States Army dirigible. To meet an increasing demand for flying instruction he next organized the Curtiss Exhibition Company, and for several years gave personal flying instruction.

One of Curtiss' triumphs came with his spectacular two-stop flight down the Hudson River, May 29, 1910, in which he covered 150 miles in two hours, 51 minutes, and won a \$10,000 prize. The next year he invented the first hydro-airplane, and in 1912 the first flying boat. Meanwhile he accomplished the first flight from land to water and from water to land at San Diego, Feb. 23, 1911.

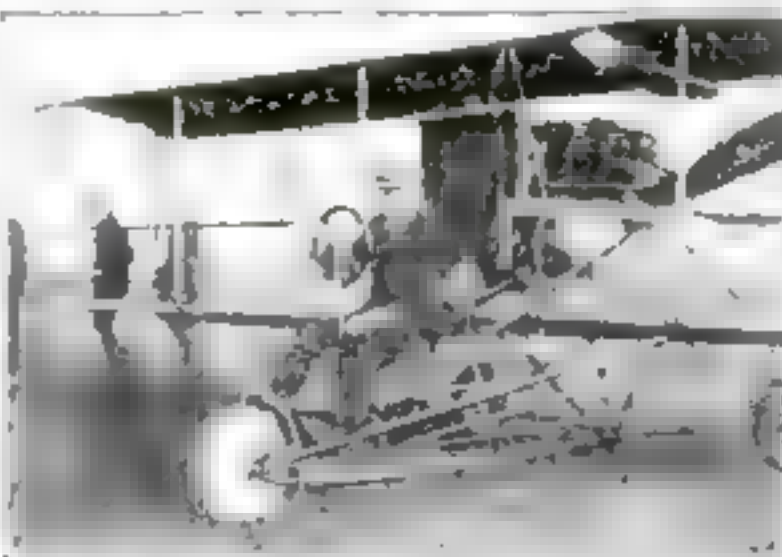
Following the formation of the Curtiss Motor Company he was commissioned in 1913 by Rodman Wanamaker to construct the first transatlantic flying boat. This boat was partially completed when the war began in 1914, but the transatlantic flight was abandoned.

His War Record

The Curtiss Aeroplane and Motor Corporation was organized in 1916 with \$9,000,000 capital. This company eventually included nine plants and five flying stations. With America's entry into the war larger plants were added. The number of different models of airplanes, seaplanes, and flying boats designed by Curtiss and his associates reached 200. In all, 7079 planes and 3292 motors were built by the Curtiss organization during the war.

When the war ended, Curtiss concentrated his attention on his plant at Garden City, Long Island, where he built the NC transatlantic boats and new machines of the commercial type, including the Curtiss Oriole, Curtiss Seagull, Curtiss Eagle, the 10-passenger plane, and the Wasp, which formerly held the world's altitude record. Other special designs for commercial and mail service are now being developed at Garden City, where Curtiss, as fond of mechanics and speed as he was in boyhood, is still active in designing and developing new types of craft for future air commerce.

A new model, on the average, every six weeks—that's the Curtiss idea of speed.



The pioneer among pioneer air adventurers seated in one of his earliest biplanes

signed new planes, built the first Vee type air- and water-cooled motors, and developed the aileron system of control. So rapid was his progress that, nine months after the organization of the association, Curtiss, piloting the historic "June Bug," July 4, 1908, won a trophy for a flight of one kilometer straight-away.

In 1909 Curtiss began the manufacture of airplanes at Hammondsport, producing the machine which became famous as the "Curtiss type of airplane." In one of these machines he won the Gordon Bennett international speed event at Rheims, France, and gained international fame.

Returning to America he perfected a successful engine for dirigibles, and with Captain Thomas S. Baldwin received the contract for

opinion of leading airmen, aviation is a profession which should be undertaken in the same spirit as that in which a man sets out to learn medicine or the law. These experts declare that four years is not too long to spend in learning to be an aviator. When manufacturing conditions improve, the pilot who has obtained his training in the shops and by long commercial experience will probably gain the best positions in the profession.

Some young fellows who have sought the best possible training in aviation, without cost to themselves, have found jobs in an airplane factory. The mechanic's apprentice or a shop helper in such a factory receives as thorough training in mechanics as if he were an apprentice to a machinist. The wages, naturally, are low—from \$12 to \$16 a week. The work consists of overhauling motors, and being generally useful about the shop. The apprenticeship lasts not more than two years, leading to work as a full-fledged "ground mechanic," earning from 70 to 80 cents an hour—the same wages as a machinist.

The alert and capable man may soon advance from this stage to the position of flying mechanic, accompanying the pilot on his regular commercial runs. This is the best possible way of learning to fly. You become assistant to the pilot. You help him make landings. You are responsible for the engine, and after 600 hours in the air, you become eligible for examination for a pilot's license. On commercial routes, 600 flying hours can be piled up in less than a year, during which your wages as flying mechanic are at least \$35 a week. A successful pilot earns from \$50 a week up, in addition to his expenses; and after a few years' flying experience, with the growth of the game, he may become a salesman, a traffic manager, or an executive, with earnings dependent upon his ability.

The wages in aviation compare favorably with those in other professions. The opportunities, with the almost inevitable expansion of the business close at hand, are incomparably greater than those of the mechanical or automotive trades; and yet after talking with pilots and executives now finding their career in the air, one finds that

the romance of flying still seems to them its most desirable aspect.

The aviator must be a man above the average. The lives of his passengers depend directly upon his skill. He must combine in his own person the functions and

Uncle Sam's Expert Sees Need for New Pilots

FLYING almost out of sight, to a height of 40,800 feet, Lieut. J. A. Macready shattered the world's altitude record Sept. 29, 1921. He is now chief test pilot at McCook Field, Dayton, Ohio, where he passes upon all new improvements, both of engine and plane, as they are submitted to Uncle Sam.

Macready is confident that the industry that already has brought fame and success to himself, will offer like careers to others. "Even now," he says, "there is an opportunity for young men with technical and practical aviation knowledge, combined with inventive brains. I am firmly convinced that in time travel by air will be the fastest, cheapest, safest, and most pleasant means of transportation."

"With the development of transportation lines and systems, superintendents, managers, and presidents will be needed. Many profitable transportation routes are now available, and young men with brains and money are needed to develop them."



abilities of a large crew. He must be engineer, pilot, and navigator. But the knowledge that he is master of the last realm to be conquered by man is a compensation for his difficult work.

Aviation will never become humdrum or dull, and because it appeals to the imagination, the man who combines a love of adventure with a natural aptitude for mechanics will be wise to look into the possibilities of finding a profitable career in the air.

How Safe Is Flying?

(Editor's Note)

WHENEVER an airplane meets disaster, many people throw up their hands in horror at the "fatal riskiness" of aviation—forgetting, perhaps, our national

yearly average of something like 3000 deaths in automobile accidents.

While no pretence can make out flying as a wholly "safe" mode of travel, its comparative safety is shown by the 1921 records of flying compiled by the Aeronautical Chamber of Commerce of America. Nearly half a million civilians, it is estimated, traveled 6,600,000 miles in 1200 aircraft engaged in civil flying in the United States. Yet during this period only 138 accidents occurred. There were 55 deaths in 33 of these accidents; 89 injuries in 42 of them, and in 48 accidents there were no casualties. Forty-nine of the accidents were attributed to pilots, and 20 to inadequate landing fields or total lack of terminal facilities.

Moreover, the one great commercial air transportation company now operating in the United States has not had a fatal accident to passengers on its flying boats in two years' flying history.

In fact, one of the most encouraging signs that the day of profitable and reliable air lines—linking our cities with scheduled passenger, freight, and mail service—may not be far distant, is to be found in the report recently submitted to the Director of Naval Aviation by this company, owning the Aeromarine passenger planes. It operates a daily mail and passenger service between Key West and Havana, Cuba, according to the report; also between Miami, Fla., and Bimini, and between Miami and Key West. Its fleet consists of six eleven-passenger converted navy flying cruisers and six five-passenger flying boats. In addition to scheduled service, the company engages in special charter flights.

The Aeromarine flying boats made 786 complete flights, the report points out, in the four months from November 15, 1921, to March 15, 1922, with a record of 640 hours flown, and 268,638 passenger miles. Of these flights, 171 were on the 100-mile Key West-Havana route, while the charter and miscellaneous flights totalled 359.

During these operations, not a passenger nor employee was injured, and only five boats were forced to return to their bases. The schedules were maintained throughout, with the exception of these five flights, according to the report.

In two years of operation, the report discloses, the company's flying boats in passenger service have flown a distance of more than 150,000 miles, and have carried 10,700 passengers, without a mishap.

Retriever Will Pick Up Your Golf Ball



THE golf enthusiast may save energy for the next drive by the use of a new golf ball retriever, fastened to the putter handle, by which he can pick the ball out of the cup or from the green without stooping.

The novelty consists of a small nickel-plated brass cup the inside diameter of which is exactly the same as that of a golf ball. When the ball falls into the hole, the handle of the putter with the retriever in place is inserted, and pressed over the ball, which is caught in the cup and withdrawn. The inventor of the retriever claims that the extra weight at the end of the club will enable the player to putt more accurately.

Pocket Knife Carries an Outfit of Tools

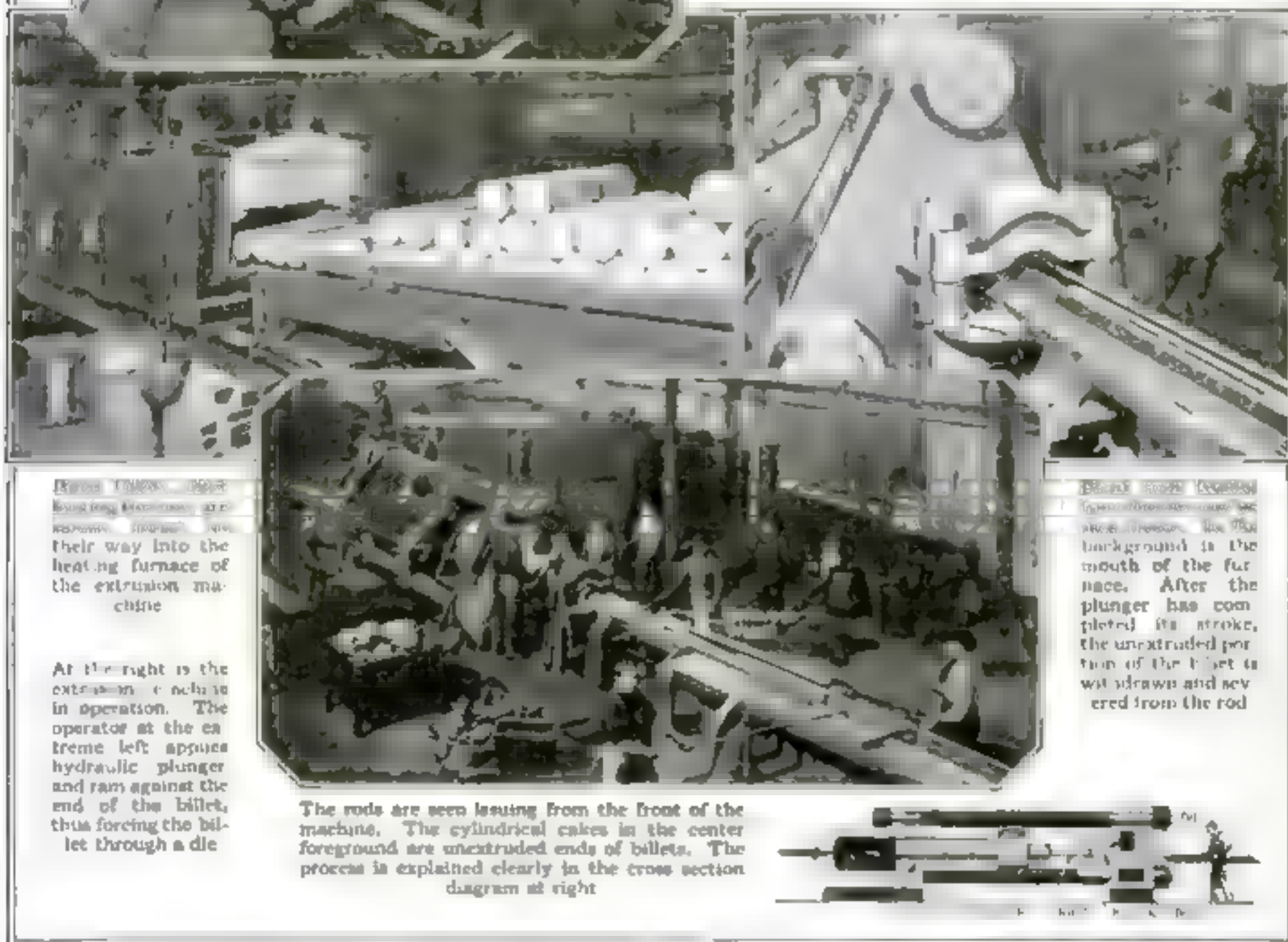


NOW that a corkscrew on a pocket knife serves only as a reminder of days gone forever, it has been replaced by a small monkey wrench that is a convenience in working around an automobile.

The new knife is large pocket size, and its outfit of tools includes, besides the pocket wrench, a heavy knife blade, a screwdriver, and an arrangement to cut wire.

Huge Ram Squeezes Brass into Rods

Great advances in the manufacture of brass rods have been attained with the use of an extrusion or "squeezing out" machine in which red-hot billets, half a foot in diameter, forced through a die by a ram, issue from the machine in the form of rods as thin as half an inch. At the left an operator is shown sawing the "gates" or jagged ends from billets.



Left: Billets—Red-hot billets, half a foot in diameter, are being sawed into their way into the heating furnace of the extrusion machine.

At the right is the extrusion machine in operation. The operator at the extreme left applies hydraulic plunger and ram against the end of the billet, thus forcing the billet through a die.

The rods are seen issuing from the front of the machine. The cylindrical cakes in the center foreground are unextruded ends of billets. The process is explained clearly in the cross section diagram at right.

Right: Rods—The rods are being extruded from the machine. The background is the mouth of the furnace. After the plunger has completed its stroke, the unextruded portion of the billet is withdrawn and severed from the rod.

Weighing Jacks Protect Highways from Overloaded Trucks

WEIGHING jacks with which the load carried by a heavy truck may be ascertained by road police are helping Maryland protect its new state roads from damage by overweight vehicles. Most roads are constructed to withstand a moving load of 10 tons. Heavier loads break down the subgrade and start ruts, the police assert.

Each weighing machine consists of a screwjack operating in an oil-filled cylinder. When four of these jacks are placed under the suspected truck, lifting it clear of the ground, its weight is transferred to the oil cylinders and can be read directly on the

pressure gages. If the truck is found to weigh more than 10 tons, the excess material is unloaded by the roadside. The jacks are of aluminum alloy, weighing only

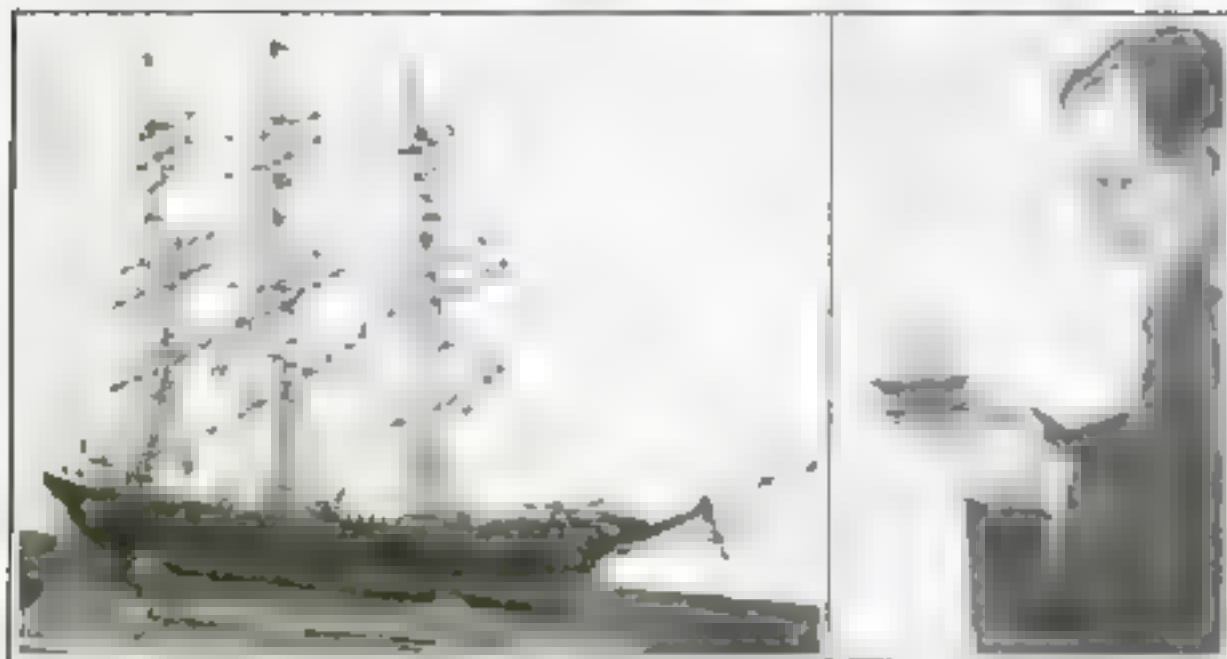
40 pounds each, so that the inspectors can carry them about in a light car.

State officials estimate that this supervision reduced overloading 75 per cent within 30 days. California has also recently passed a law limiting the weight of motor trucks, and road officials and taxpayers are seeking to reduce the maximum permissible weight below the limit now set — 30,000 pounds gross weight for four wheeled trucks, and 40,000 pounds for six wheeled vehicles, providing the axles are at least 96 inches apart, and there are not more than 800 pounds on each inch of rubber tire width.



Four screwjacks, operating in oil-filled cylinders, lift the suspected truck clear of the ground. The weight is then read on pressure gages.

Smallest Model Ship Is Fully Equipped



ONLY a crew of ants could find deck room in the model of the clipper ship *Ariel*, constructed by J. A. Belhouse, of Medford, Mass., and said to be the smallest accurate ship model on record.

Although but $5\frac{1}{4}$ inches in length, the model is completely fitted with gear and rigging, constructed exactly to scale, and is a masterpiece of microscopic craftsmanship.

The smallness of the perfectly proportioned ship may be realized by the fact that the transverse "timber" in the foreground of the photograph, joining the two up-

rights of the cradle, was fashioned from an ordinary toothpick.

Each crosspiece is fastened to the masts by fine wires passing through holes pierced by a drill of hairlike fineness, and each ratline of the shrouds is a single horsehair. The blocks are the tiniest beads the maker could buy.

The model can be held in the palm of one hand. The detailed dimensions are: length over all, $5\frac{1}{4}$ inches; length of hull, 4 inches; beam, $1\frac{1}{16}$ inches; depth, $\frac{1}{2}$ inch; height of mainmast, $3\frac{1}{4}$ inches; length of mainyard, $2\frac{1}{2}$ inches.

Seed Threshed from Cones to Build New Forests

SEED for planting pine forests in connection with the Federal reforestation program is gathered by robbing squirrels of the hoard of pine cones collected for winter food, and threshing the cones in homemade churns.

The forest rangers first allow the cones to dry thoroughly in the sun and then throw them into a framework covered with a galvanized wire cloth. The box is then rotated with a hand crank. As the cones are tossed about, the friction and jolting



As the dried cones are shaken, the seeds fall through wire mesh.

loosen the seeds, which fall through the wire mesh to a cloth spread under the churn.

About 50,000 pounds of valuable seed were recovered last year in this manner—enough to set out 50,000,000 trees. About 8,000,000 acres in our national forests are now being reforested with seedling pine.

The Editor will be glad to supply the names and addresses of manufacturers of devices mentioned in this issue.



Semi-Overalls Protect the Trouser Legs

SEMI-OVERALLS, or protectors for the lower half of the trouser legs, have recently been invented by Edward L. Richardson, of Brooklyn, N. Y., for use by those who wear dusters to protect their clothes. The protectors are suspended by straps from the belt and, fitting loosely, will not wrinkle the trousers.

Radio Doctor Gives First Aid at Sea

PASSENGERS on vessels at sea anywhere near New York City may now receive free medical advice by radio. A wireless dispensary is available every hour of the day and night. Last year more than 50 cases were treated in this way.

Although most seagoing vessels are equipped with radio, about 80 per cent have no doctors aboard, and thus a population equal to that of a small city is constantly afloat within radio distance of New York without medical attention.

The radio dispensary operating from New York is the first of its kind. The work is directed by the Seamen's Aid Society, which receives calls and dispenses medical advice over a range equal to half the width of the Atlantic.

An alert watch is maintained day and night by radio men in the receiving station in the tower of the Seamen's Institute. Arrangements have been made with physicians so that at whatever hour the call is picked up, a doctor will be instantly available. These calls take precedence over all others, except the "SOS."

When Delay Is Dangerous

Since most ships carry well stocked medicine chests and first aid supplies, the radio doctor is able to work with efficient tools. The ailments most frequently brought to the radio doctor are appendicitis and ptomaine poisoning, both cases in which delays are dangerous. The radio doctor is able to get the temperature and pulse of the patient, prescribe medicines and direct the handling of the treatment effectively. In case of an accident, such as a bad fall from the rigging, he can give directions for first aid treatment.

A hit or miss call for medical assistance is likely to result in the loss of valuable time; this new service will do away with that possibility.

Gaging Machine Records Depth of Oil Wells



THE depth of an oil well can now be ascertained accurately at any moment by a simple gaging machine recently designed by C. E. Van Ostrand, of the United States Geological Survey.

The apparatus consists of a wheel mounted between two parallel bars that hold it over the opening of the oil-well casing. The sand line is clutched against this wheel by two idlers. Coilsprings regulate the tension. The depth is recorded in feet by use of a revolution counter.

This instrument has verified the assertion that the deepest oil well in the United States is the 7579-foot hole in the town of Fairmont, W. Va.

Mechanical Surveying Machine Maps Hillsides and Valleys

Like a Giant Tracing the Landscape

BY MEANS of a newly invented camera and drafting machine based on the principle of the stereoscope, it is now possible to make an accurate surveyor's contour map mechanically, plotting every ditch, hillock, and tree stump on a mountainside several miles away to an accuracy of inches—and this without calculation and without sending a surveyor over the country.

Instead of the usual method of drawing contour lines by interpolation—that is, locating a few important points of equal elevation by triangulation, then drawing in the remaining points of the same elevation by guesswork from rough sketches made by a surveyor in the field—the new method locates exactly each individual point with the aid of photographs, the stereoscope, and a complicated mechanism resembling a pantograph. The new instruments are called the "photo theodolite" and the "stereoautograph."

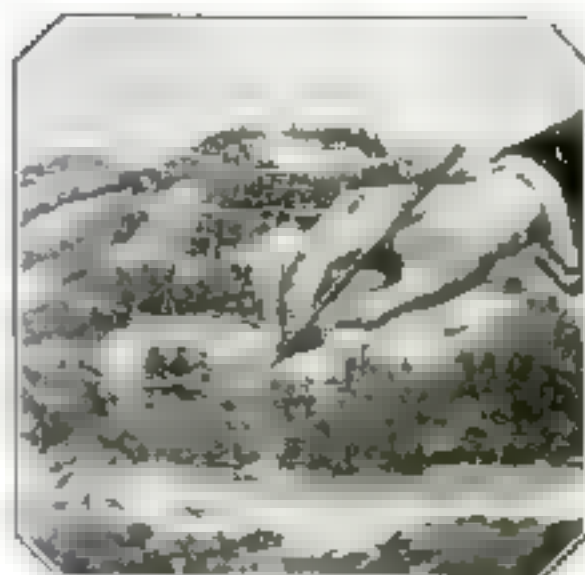
How Photographs Are Taken

In the field, the first step in this stereoautographic method is to choose a baseline. The camera is set up at each end of this line and oriented with a theodolite—a telescopic device for measuring horizontal and vertical angles—placed above the lens. Photographs are then taken of the country to be mapped, each at certain definite angles to the baseline, which angles are alike for the plates taken from each station. The height of the stations is ascertained by the usual methods, and the length of the baseline measured photogrammetrically. This ends the field work. It has taken about two hours, and in 10 hours more the map can be drawn—an operation that would require several days of calculation and plotting by former methods.

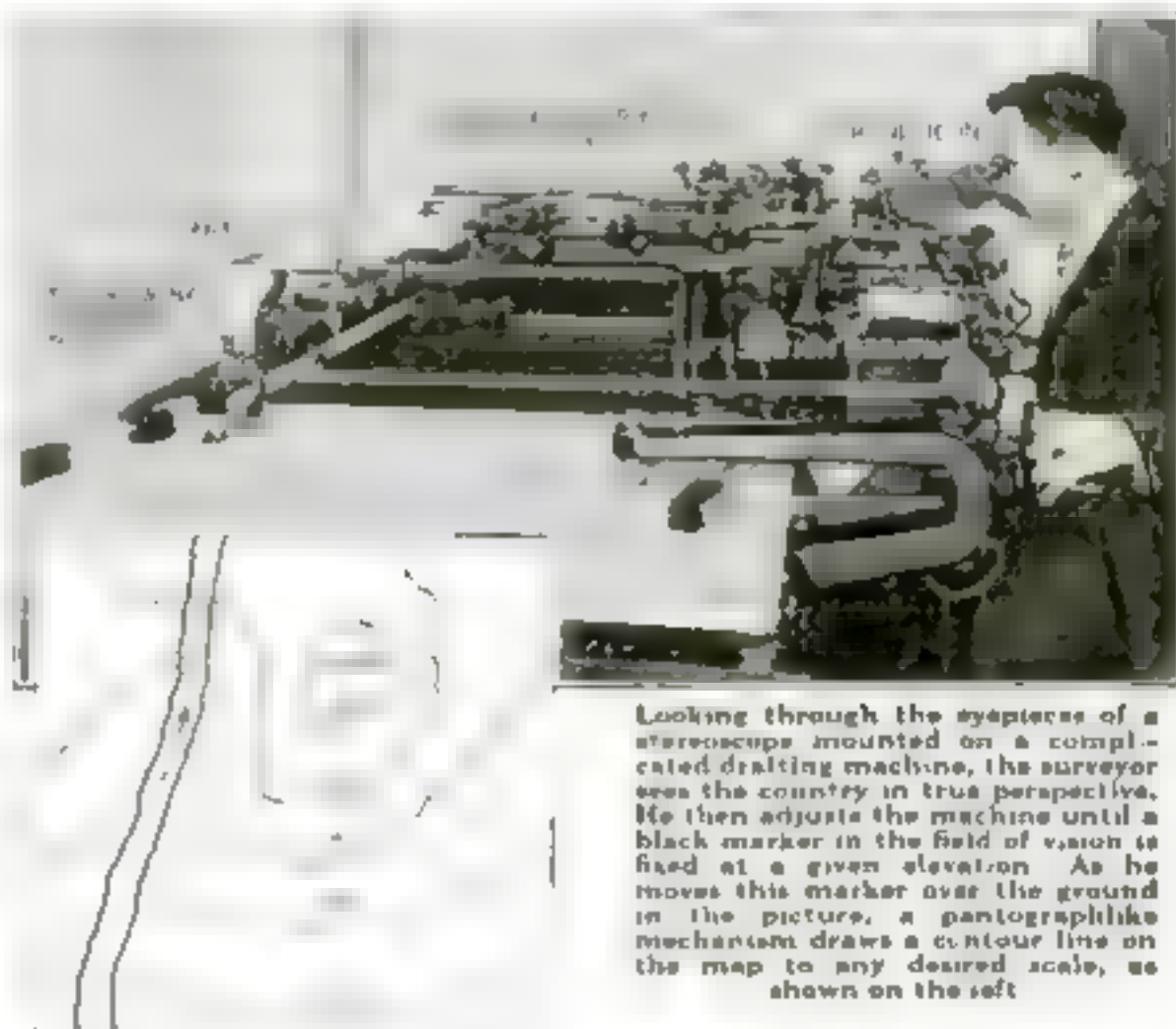
Two plates, one from the left and one from the right station, are now placed in a stereoscope, mounted on the frame of a

complicated drafting machine. The machine is adjusted so that when the surveyor looks through the eyepieces, his right eye sees the country as photographed from the right station, while his left eye sees it as taken from the left station.

Thanks to the stereoscopic principle, the country is seen in perspective in three dimensions, and not flat like a photograph. Within the field of view appears a little black arrow. This is a marker, or "wandering point" which, by adjusting the appa-



With the machine method, the surveyor is like a giant moving the point of his pencil in horizontal planes over actual country.



Looking through the eyepieces of a stereoscope mounted on a complicated drafting machine, the surveyor sees the country in true perspective. He then adjusts the machine until a black marker in the field of vision is fixed at a given elevation. As he moves this marker over the ground in the picture, a pantographlike mechanism draws a contour line on the map to any desired scale, as shown on the left.

ratus, can be set at any desired height.

Suppose the surveyor took his pictures at 100 feet above sea level and wished to draw a 110-foot contour line. He adjusts the machine until the marker stands at this elevation. Thereafter, wherever the wandering marker goes horizontally, it will always be 110 feet above sea level.

Machine Draws Contour Lines

Accordingly the surveyor moves this arrow across the picture, always keeping its "feet" in contact with the ground. As he does so, a complicated arrangement, somewhat like a pantograph, draws a contour line upon the map to any scale desired. It is exactly as if the surveyor were a giant, with his eyes as far apart as the length of the baseline, and a pencil in his hand, the point of which always moved in a horizontal plane of known height. If the giant moved this over the actual country, he would determine points of equal elevation, thus tracing a contour line.

The lenses and gears of the new instrument enable the surveyor to do the same thing. As the pictures are taken at a known angle from a known base, every point in them is really located by triangulation.

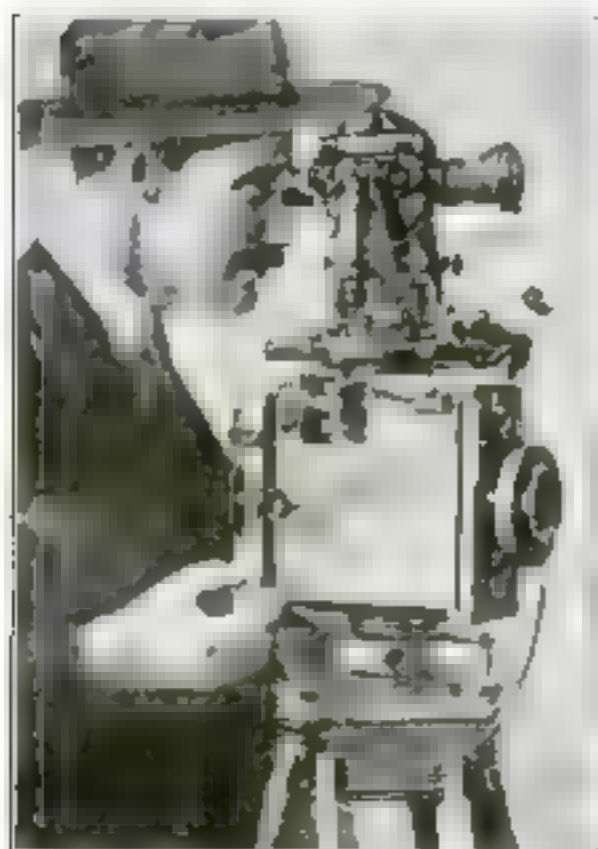
Wonders Performed at High Pressure

SQUEEZING mild steel into the cracks and folds of a soft rubber washer, as into a die, deforming steel bars with an ordinary paraffin wax candle, and compressing water to 20 per cent of its original volume are some of the physical marvels possible at a pressure of 500,000 pounds a square inch, reports Mr. P. W. Bridgman, of Harvard University.

Under pressures of from 12,000 to 20,000 atmospheres, the character of many common substances alters completely. Hydrogen gas, for example, will force its way through the pores of a thick steel bottle, and eventually will make a crack that can be seen with the naked eye.

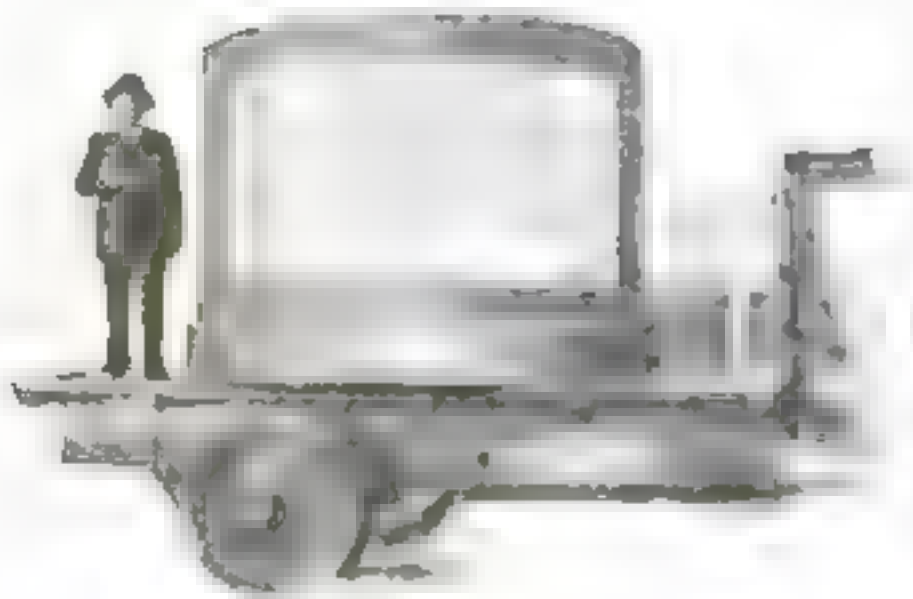
Hot liquids can be frozen by the application of pressure alone. At 300,000 pounds pressure, water will turn to ice, though a thermometer may show it is at 180° F.

The first effect of pressure on ice is to lower the freezing point, but if the force is increased, a strange collapse comes at 2000 atmospheres. The force that holds the molecules apart is overcome, and the ice shrinks 18 per cent in volume. It will then sink in water instead of floating.



At each end of a known baseline, photographs of the country to be mapped are taken with this camera.

Largest Cheese Weighs 12 Tons



"UNCLE" Horace Rees, of Lowville, N. Y., dean of American cheesemakers, recently celebrated his eighty-first birthday by pouring the largest cheese ever manufactured. It is a monster, standing over six feet high, and weighing slightly over 12 tons—enough, it is computed, to make 300,000 sandwiches.

It is extremely difficult to make such a cheese, not only because of the size, but because milk from many different dairies must be treated in exactly the same way. Twenty-one dairies contributed to the making of this world's record. Several had to save two days' supply of milk, for 125 tons of milk were used. This supply represented a day's output for more than 10,000 cows. The cheese was made for exhibition at the State Fair.

Tractor Is Mechanical Loader



Pogo Sticks Invented to Hop across Stream

POGO sticks were invented about 300 years ago by a blacksmith in a Transylvanian village who wanted to keep his feet dry, according to Mr. G. Piarcayk, of New York City. His account is as follows:

Pogo was originally the name of a small Transylvanian village on the bank of a stream, across which lay the cattle pastures. A series of rock piles was placed in the stream so that an active man might cross by leaping from one pile to the next.

In the seventeenth century, a wandering mechanic invented the first rude pogo stick to enable any one in the village to hop from one rock pile to another.



WHEREVER there is a job of heavy shoveling, the mechanical loader, invented by A. H. Lesman, of Des Moines, Ia., does the work with the power derived from a small tractor. The driver, sitting in the tractor seat, controls the tractor by operating a single lever.

The loader is supported by a strong frame of I beams and is raised and lowered by wire ropes running over pulleys from a small winch attached to the engine. Shoveling is accomplished by manipulating two lighter levers attached to the top of the shovel, which push the scoop forward as it drops to the bottom of the pile of material to be removed, or tilt it forward and downward after it has been raised over the tail of the wagon being loaded, thus allowing the material to slide on.

Two Trees from One Trunk

IN THE historic old churchyard of St. Mark's in the Bowery, New York City, are two very old trees, one of which, though they are both now dead,

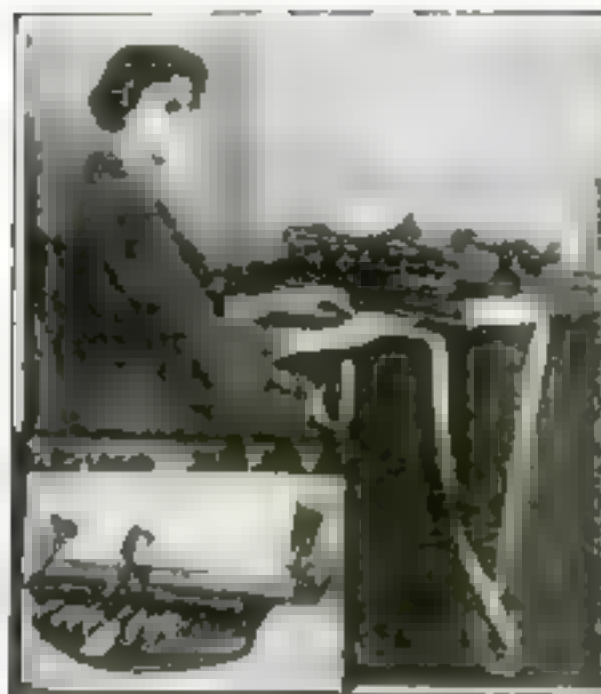
While endeavoring to remove some old burial vaults in the yard, the sexton discovered that when the roots of a very old tree expanded, they came in contact with the vault roofs and were unable to grow upward. Instead, they spread out on the surface of the vaults and then appeared on the surface. At this point a second tree developed, which can be seen in the photograph below, beside the "mother" tree.



Pavement Is Billboard

CITY streets and sidewalks may be converted into temporary billboards by an invention resembling a lawnmower that prints the advertising message in water on the asphalt.

As the machine is pushed along by its operator, a spray of water from the tank in the upper half passes through a perforated belt or drum that acts as a stencil. The belt is of fine wire gauze with waterproof letters fastened upon it. In consequence it leaves a band of wet, dark pavement behind it, upon which the words of the advertisement stand out dry and white, as shown in the illustration below.



How Blind Stenographer Takes Dictation

THAT blindness does not bar the person thus afflicted from being self supporting has been demonstrated by Miss Grace Keator, a young blind woman of New York, who is shown above in her office, reading the raised characters of machine-made stenographic notes which she transcribes on a conventional office typewriter.

To take dictation Miss Keator uses the machine at her right, which writes stenographic characters in raised form on an automatically progressing paper tape.

The inset shows the new type-writing machine for the hand which instead of employing a raised tape, embosses the letters and figures of the Braille system in lines on a sheet of paper. From this embossed record the blind operator transcribes the dictated notes in ink-print on an ordinary typewriter.

The characters that the new machine prints, or rather embosses, are formed of the combinations of the six points of the Braille system.

Pitch Coins for Charity

TOSSING away coins for charity has become a "rattling good game" since E. Fred Cullen, a Boston business man, invented a money scoop for use by the Red Cross in collecting funds for disabled soldiers.

Instead of handing your money to a collector, you toss it into the scoop. The

rattle of the coin as it falls through the hollow tin handle draws the attention of passers-by to the appeal painted on the device. The handle also contains a slot for inserting dollar bills in case the donor does not trust his throwing arm.

Money tossed into this scoop rattles down the tin handle into a collection box.



Skyscraper Lumber Piles

SKYSCRAPER lumber piles that tower from 50 to 75 feet above the roadway are becoming common in the lumber yards of Puget Sound since the introduction of a mechanical stacker that works on the principle of a bucket loader. The planks are placed in brackets attached to an endless chain, lifted over the top of the tower and down the other side, where they are transferred to the pile.

The piles are sometimes from 30 to 95 feet high, resting on concrete sills sunk 20 feet below the level of the road, so that about 35 feet of the stack can be built by mechanical aid.

Gold Film Is Transparent

GOLD 1/2,798,000 of an inch thick, or 10,584 times thinner than the ordinary sheet of printing paper has recently been produced. One grain of the precious metal of this thickness covers nearly four square feet of area and is perfectly transparent.

The process of obtaining the thinnest film is to cut a sheet of copper to a determined size and place it in an electric bath, where sufficient gold is deposited on one surface of the plate, to produce the finest gold color discernible. To separate the film of gold from the copper, the gold-plated copper strip is immersed in a weak solution of nitric acid for several days. The copper is entirely dissolved, leaving the film of gold floating on the surface of the liquid. The film is then collected on a glass plate.



Thermometer Tubes Pass Rigid Inspection

YOUR health may depend upon the skill with which inspectors of clinical thermometer tubes recognize microscopic defects in the glass. Thermometer "cans" are now tested for uniformity of bore, perfection of the magnifying effect of the rounded front of the tube, and for freedom from blister bubbles and other exterior defects. These tests are so rigid that 75 per cent of the material bought is rejected as unfit.

The most important of the tests determines the size and uniformity of the bore. The hole in a thermometer tube is only eight ten thousandths of an inch in diameter—less than one twentieth the thickness of a hair. Upon the perfection of the bore depends the size of the bulb, which must be very large comparatively to produce a range of nearly 80 degrees on the short stem. The bulb of a clinical thermometer usually has 1000 times the capacity of the bore.

Portable "Bike" Folds Up

NOW comes the portable bicycle to join the company of portable typewriters, sewing machines, phonographs, and garages. The new invention was designed for the convenience of travelers and motorists, for use on tours and camping trips—wherever space is valuable.

Since the wheels are much smaller than those of the average bicycle for adults, and the frame is collapsible, the new "bike" can be folded into a compact bundle, and even packed into a trunk. The frame is so constructed that it may be adjusted to fit adults or children.

Tested by riders in the recent six-day bicycle race in New York City, the "portable" was found to be durable and speedy.

How the portable bicycle, with collapsible frame is folded for packing.



Teaching a Cranky River to Control Itself

Retarding System, Based on Invention of Self-Sinking Pile, Forces the Missouri to Form Sand Bars and Protect Its Banks

FOR 41 years engineers have battled to bridle the turbulent Missouri River; yet each spring the unruly stream, roaring defiance to the mastery of man, has torn itself from its channels, plowed through fertile fields and destroyed bank protections designed to curb it. There have been times when the Iowa farmer, owner of rich acres on the river bank in January, has, in April, found himself the proprietor of worthless stretches of sand in Missouri, half a mile from the river.

But, at last, the "Big Muddy," that for years has laughed at revetments and solid dams of concrete and steel, is being induced to control itself! The self-taming process is being accomplished by the use of a newly invented self-driving concrete pile that sinks deep into the soft river bed and becomes a secure anchor for mats of trees and brushwood to retard the stream. Behind these mats the Missouri deposits portions of its load of silt, quickly building underwater sandbars to deflect the current from its banks and hold it to its channel.

To Save Rich Farmlands

By the new "retard" method, engineers hope to save millions of acres of fertile land along the Missouri and the lower Mississippi from the danger of periodic inundation.

The amount of dirt and sediment carried by a river depends upon the speed of the current. If you can slow up the stream by an obstruction, some of the dirt carried by the water will be dropped, the heaviest particles first. With a river like the Missouri, a sandbar grows up like magic behind any obstruction, affording the best possible protection to the banks behind it. Effective obstructions could not be made with ordinary piles, for the ice carried them away. The new pile, however, buries itself under the river bottom, where the water cannot loosen it. Within a few days or hours before a flood begins rafts of brushwood can be anchored at the danger points.

Simple as it appears, the invention of the new pile brings into play a new adaptation of the science of hydraulics. The pile is a thick tube of reinforced concrete with a four-inch pipe running through its center, and a two-inch nozzle at the point of the pile. At intervals of from three to four feet half-inch holes are bored diagonally into the inner pipe, forming jets that point upward, away from the pile point. Each jet consists of an ordinary pipe ell, extending upward for a distance of about two inches. Jets are placed on all four sides of the pile, which is cast 52 feet long, 16 inches square, and contains about $2\frac{1}{2}$ cubic yards of concrete.

In driving one of these piles



How the hollow concrete pile, held vertically by a crane, drives itself. Jets of water, spurting upward, prevent sediment from clinging to the sides, thus eliminating surface friction.

in the stream bed, a hose is connected with the four-inch inner pipe at the upper end, or head, of the pile. By means of a pump with a capacity of 1000 gallons a minute, water is forced into the pile at a pressure of 150 pounds a square inch. A powerful

stream of water squirts from the two-inch opening at the point, and smaller streams shoot upward from all the side jets.

While the pile is held in a vertical position by a derrick, the stream of water from the point bores its way into the soil and the pile sinks rapidly by its own weight. It would not sink far if it were not for the side jets. Meanwhile, water spurting from the side jets keeps sediment from clinging to the sides of the pile. This eliminates surface or "skin" friction. Thus the pile buries itself in about seven minutes.

Mat of Trees Retards Current

Four feet from the upper end, a dozen one-inch wire cables, each 200 feet long, lead from the anchored pile to which they are firmly fastened.

While the pile is being driven, along the bank scores of small trees are cut and loaded on working scows. A wire cable is passed around the butt of each tree in a half hitch, and held by two heavy staples. In this manner a mat is formed of 25 or 30 trees. The barge is towed about 100 feet downstream from the pile, and there the mats are attached to the cables leading from the pile at the bottom of the stream, one mat for each cable. For additional strength, a second cable goes from each mat to a strong post on shore. The trees are placed with their tops pointing downstream. The barge is then towed out from beneath the mats, and as soon as they strike the water, the engineers' work is done. The river begins to "control itself" at once.

The force of the current causes the trees to settle to the bottom of the river. The masses of interlaced branches retard the current, and sand and silt are deposited on the river bottom behind the mat. As the current slackens, the mat lifts itself slightly from the bottom, and the sandbar is thus gradually built up until it almost reaches the surface.

Owing to their action upon the current of the river, the mats are called "retards." The principle of the retard differs from that of masonry or concrete jetties, which divert the current of the stream and cause a swirling eddy near the jatty in which sand is deposited. It also differs from "rip-rapping," or covering the river banks with layers of stone or willow twigs in order to prevent the stream from eating the bank away. Both these forms of protection are liable to be carried away by ice. With the retard system the mats are gradually sanded in and are thus protected from ice packs, while the anchor pile that holds the retards in position is beneath the stream bed, out of reach of all possible

Vast Farmlands Await Rescuers

WHEN at last our army engineers completely conquer the Mississippi River, an area said to be equal to the four states of Delaware, Connecticut, Rhode Island, and Massachusetts will be added to the productive farmland of the United States.

The invention of a new concrete pile—almost sensational in its simplicity—that sinks itself deep into a river bed and forms the basis of a retarding system to make the stream protect its own banks, is already taming the hitherto untamed Missouri River.

If it proves to be equally successful on the lower Mississippi, the lands recovered from swamp would be worth \$1,600,000,000. They would support a population of 7,500,000.

acour. Incidentally, as both the trees and cables are always submerged and buried in sand, they are protected against decay.

In protecting a river bank by this new method, the engineers first make a careful survey of the threatened area and chart the currents at and above the point where erosion has begun. The retards are placed where the river begins to bend, and from this point downstream they are placed at such angles and intervals as the needs of the particular situation demand, always with the idea of encouraging the maximum amount of silting, and, if possible, developing new land by making the river narrow, straight, and deep instead of broad, shallow, and winding.

In some cases three retards are enough; other bends require as many as 14. The average retard contains about 1500 trees. The largest ever built consisted of 4000 trees, the smallest, 500.

How a Railroad Was Protected

A demonstration of the complete protection afforded was recently given at Folsom, La., a few miles below Council Bluffs. Here the main line of a railroad ran close to the river bank, and for years the right of way had constantly been menaced. Vast sums had been spent in emergency protection. In one case when the bank was about to cave in, a spur track was built to the river and a train of flat cars loaded with rock was backed into the river—cars and all. But this extreme measure protected the bank only for a short time.

As soon as three retards were placed, sanding-in began, and by the time of the next flood the new sandbars had grown so high that the channel in the horseshoe curve by the river at this spot, once from 80 to 60 feet deep, had become almost entirely filled. As a result, the river formed a cut-off that left the railroad right of way more than a mile from the new stream.



Trees woven into a great mat and fastened by cables to concrete piles anchored below the river bed form a "retard" behind which a sandbar forms to deflect the current and throw it away from the bank.



A typical retard, firmly anchored along the river bank, is shown above. The map at the right shows how the river straightened its own channel after retards caused sandbars to form at a bend in the stream. Dotted arrows indicate the new channel.

It is the hope of engineers that this system, which has proved successful on the turbulent Missouri, can be generally applied to safeguard the 1200 miles of the lower Mississippi. The problem there is almost identical,

and though the volume of water is greater, the speed of the current is less.

Attempts to control the Mississippi with levees above the water level have been only partially successful. In high water periods, as during the past spring, there is a constant menace of breaks in the levees, with sudden destructive floods. The new invention that makes the river control itself by building up sand bars below the water would not eliminate this recurring menace of high water, but might be expected to protect many million dollars' worth of land.



Two-Cylinder Steam Truck Proves Practical

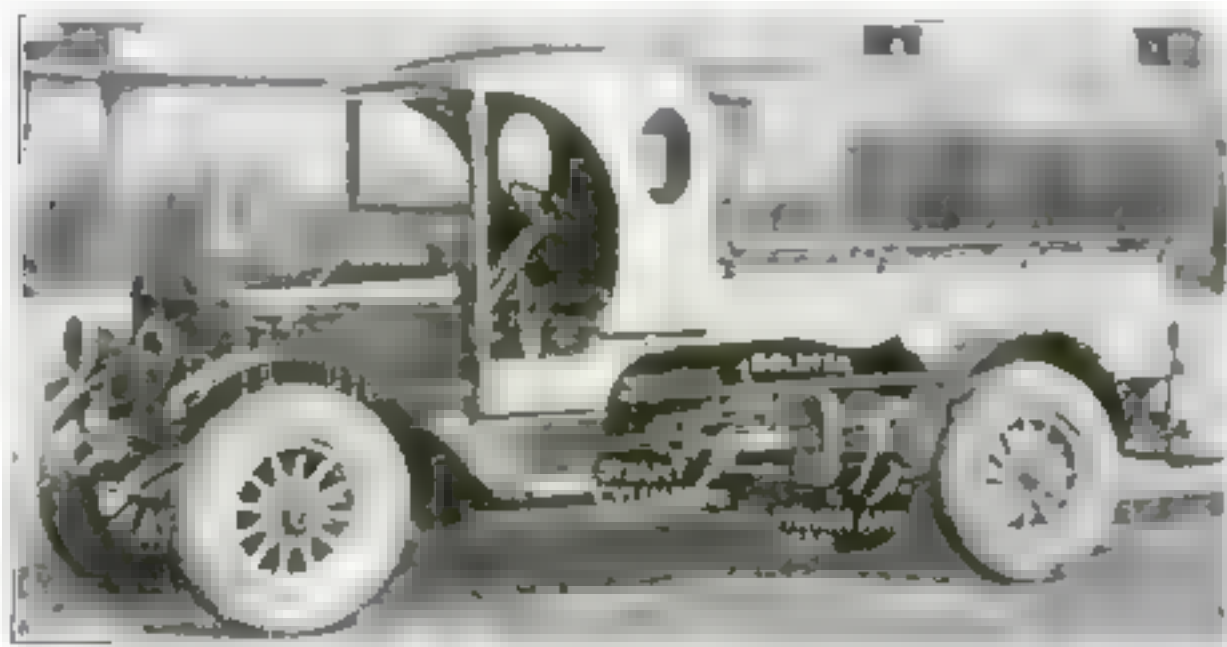
WHAT is said to be the first practical steam truck built in the United States has just made its appearance in a two and a five ton model. The fuel used is kerosene.

A fire tube boiler is located under the hood, and the engine is geared directly to the rear axle, in fact, since the differential housing also forms the crankcase, the engine and rear axle are one unit. The steam pipes run from the boiler in the front to steam cylinders just in front of the rear axle.

The usual bevel gears are eliminated. A spur gear on the crankshaft meshes directly

with a spur gear on the driving shaft, for as the engine is a two-cylinder double-acting design with valves operated by eccentrics, quick and positive speed control can be obtained by the throttle alone.

Steam trucks have proved successful and popular in England, where more than 10,000 are in operation at present. The development is ascribed to the excessive cost of gasoline. The advantages claimed for the new American truck are greater simplicity, increased power, and the economy of kerosene fuel.

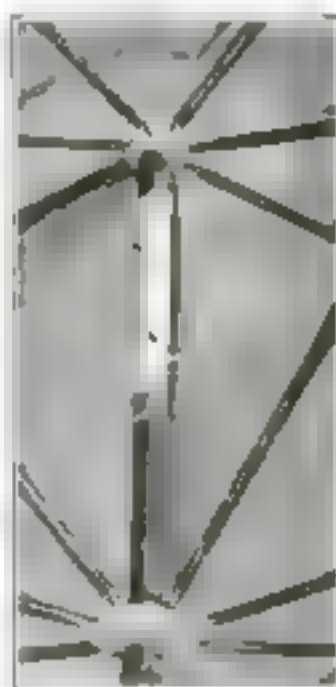


Engine and rear axle are one unit in this newly designed steam truck. The fire tube boiler is located under the hood.

It's a Wise Man Who Knows His Umbrella

UMBRELLA tags—displaying the owner's name and address, that fasten firmly to the stick above the upper catch, and are protected from the rain by a thin sheet of celluloid, have been invented by E. L. Gaines, of Seattle, Wash.

Many a man carries around a borrowed umbrella sincerely believing that he bought it himself. But if he writes his name and address on the little tag, there is no longer any excuse for mistakes in ownership.



SMALL metal weights that have become magnetized should be guarded against in making accurate scale tests, according to the United States Bureau of Standards. The Bureau suggests that all such weights be examined with a compass before use, otherwise serious errors may result.

Wire Cables Act as Bridge Girders



WIRE ropes instead of steel beams were used recently in a novel temporary bridge of 110-foot span constructed over the Kern River, Calif. The bridge is a rigid-deck truss, although four 1 1/4-inch wire cables act as its bottom chords. Construction was quick and easy, for the use of rope obviated the necessity of false work. The cost is said to have been only \$2000.

The use of rope instead of girders was possible only by seeing that all rope stressors were tension or pulling strains. In building the bridge, the four cables

were first anchored in place with great care that all sagged equally. Notched cross pieces were then placed upon them and very lightly spiked together. After all weights, even the living load of the carpenters, had been carefully balanced to avoid distorting the bridge, the braces were nailed firmly in place. Once tied, the entire span acts as a unit, and is as rigid as if it were built on a single steel girder.

Even when a load is on the bridge there is no movement of its members as in the case of ordinary suspension bridges.

New High Explosive Can Be Handled Safely

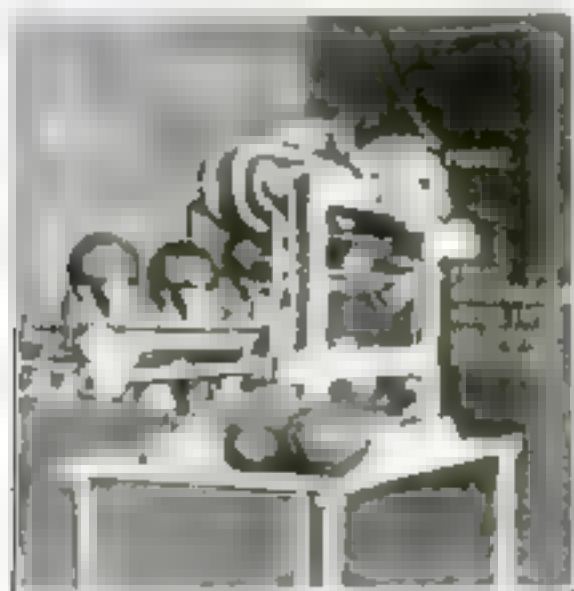
BY SHOOTING bullets through a stick of high explosive held in the hand, H. P. Hostaph, of Detroit, Mich., proves that his new product may be roughly handled with impunity. While it has the power of dynamite when exploded with a detonator, the inventor claims that it cannot be exploded accidentally even if tossed into a fire or struck by a heavy hammer.

Railroad statistics reveal that in transporting high explosives, 400 persons are killed and injured, and over \$3 000,000 in property destroyed every year by acci-



Bullets fired through this stick of high explosive fail to detonate it

dental explosions. The formula of the new product would eliminate such accidents, it is claimed. The composition is a slight variation of the TNT used in the war. Its qualities are said not to be affected by temperature or age.



Fruit Stamping Machine Prints Grower's Name

A PRINTING press for lemons and oranges, that will imprint on the fruit itself the grower's trademark, is the invention of Fred J. Sevigne, of Milford, N. H. It can be utilized for marking any spherical or near spherical object, from baseballs to eggs.

The fruit to be marked comes to the machine resting in cups carried by an endless conveyor belt, and passes beneath a revolving belt of soft rubber. This bears plates of the name and address of the grower, inked by a mechanism at the top of the machine. As the fruit comes into contact with a plate, an actuating device revolves it against the stencil under pressure. Passing from the belt plate, the fruit is lifted from the cup by an automatic projector and sent down a chute to the wrapping machine.

Tracing Made Easy by Light under Board

KEEPING up with the blueprint machine will be easier for draftsmen whose work is expedited by this electrically lighted tracer. An electric light located below the work shines through the paper, and a tracing may be made more quickly and far more accurately. The size illustrated is adapted to the reproduction of drawings on the sheets of a mimeographing machine, but the device is valuable for any tracing work.



An electric light shining through a glass from below simplifies tracing work



Improved Mounting Holds Lathe Grinder Firm

BOLTED upon the compound rest of a lathe instead of to the toolpost, a new universal lathe grinder is so mounted as to secure greater rigidity and to eliminate chattering. As the frame is of aluminum alloy, the weight is kept to 22 pounds without loss of mechanical efficiency.

The grinder consists of a universal electric motor with a two-step pulley which permits a speed of 12,000 revolutions a minute on load. Tension of the driving belt is secured by sliding the motor in the slots of its base. A second slot one inch wide and three inches long, provides means of fastening the tool to the machine.

Waste from grape-juice factories may be utilized by manufacturing the stems into cream of tartar, the skins into jelly, and the seeds into oil, meal, and tannin extract.



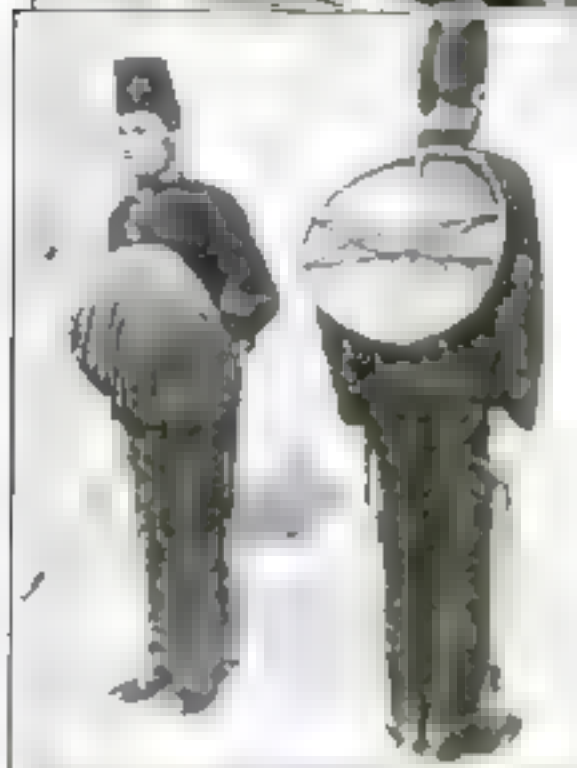
Camera Checks the "Ump" when Fans Howl

"HES—out!" The runner may kick and the fans howl. The umpire has decided and that settles it. But was the runner really out?

Until Arche M. Dunning, photographer, of Los Angeles, Calif., perfected a new method of photographing close plays, no one could say certainly whether the arbiter was right or wrong, unless a news photographer caught the play from close at hand.

From a small platform on the roof of the grand stand, Dunning photographs with telescope lenses close plays anywhere on the diamond. The pictures of the plays, when finished, appear to be taken from a distance of a few feet and show in many cases whether the umpire was right or wrong.

In one case, a game was lost because the umpire called a man out at first base. The ball beat the man to the bag, the umpire said. But when Dunning developed his photograph of the play, it showed the runner's foot touching the bag and the ball several inches away.



Let the Bottles Fly!

To protect themselves against stones, broken bottles, and other missiles hurled at them by rioters, Egyptian police are now equipped with small wicker shields. Front and back views of the shields are shown at the left. This light, tightly woven armor is as effective in stopping "brick-bats" as is the steel armor worn by police in our large cities in stopping bullets.



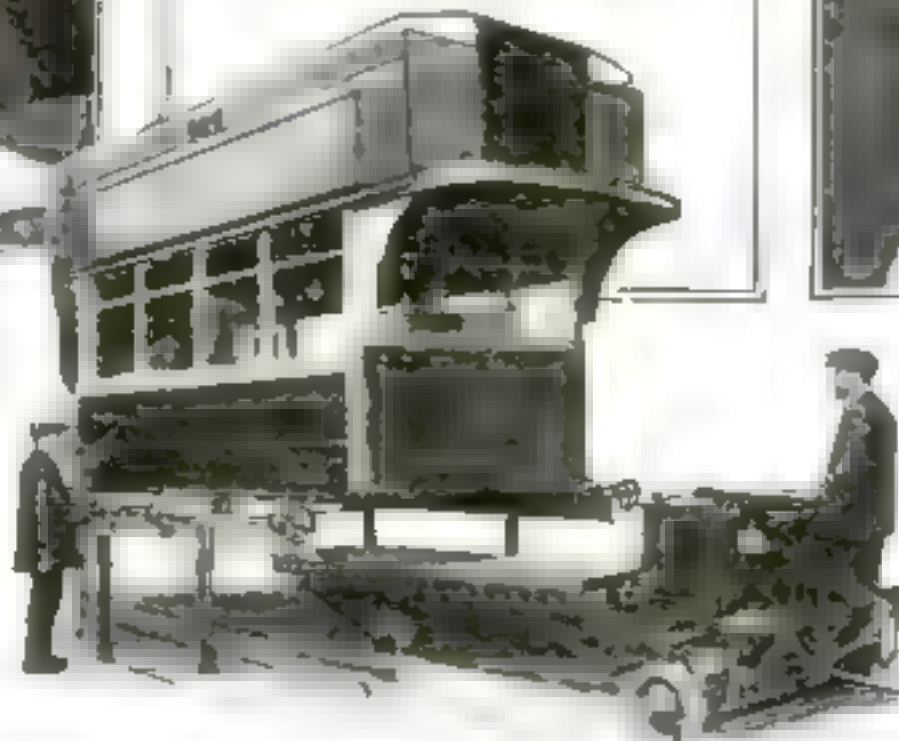
Dogs Pay Their Income Tax

Dogs that earn \$100 a week appeared recently in person at the office of the Income Tax Collector of New York City to swear to their returns. The canine plutocrats all gave their occupations as actors. Most highly paid dogs are in circuses, but some are in the movies. Two of these "actors" are said to draw salaries as high as \$50 a day.



Armless Man Writes

With a wooden disk tightly strapped against his chest from which extends a wooden rod about a foot long, with a clamp on the end for holding a pencil, this armless man soon learned to turn the pages of a book, to sketch, and to write legibly. Use of the device is being taught in the hospitals of London, England.



Hospital for Buses

At least 15 omnibuses are pulled apart and reassembled daily in the centralized motor bus hospital of the London General Omnibus Company. The photograph below shows part of the standardized equipment for handling bus bodies—a body lift and electric truck.



The Whirl of Fashion

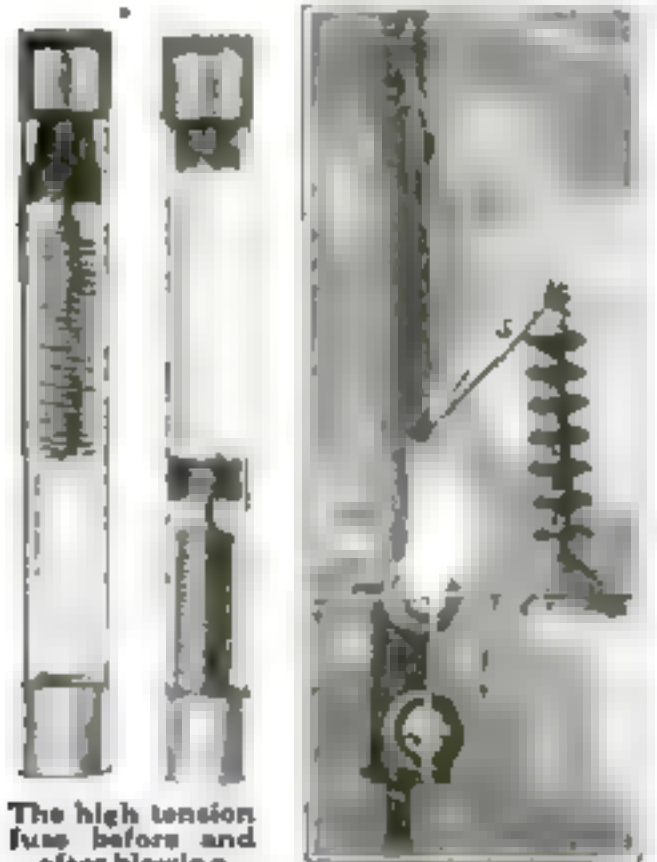
A new use for the electric fan—for hat trimming—has been discovered by Miss Ethel Beech at Miami, Fla. She electrified society there by appearing in a hat trimmed with clothespins, set off by a small electric fan and two dry cells, as pictured above.

Simple Fuse to Safeguard High Voltage Circuit

HIGH tension fuses, resembling the simple device used on lighting circuits have recently been perfected for use on circuits carrying upward of 115,000 volts and 400 amperes.

Tests on high voltage short circuits seem to prove these fuses act more rapidly than the oil circuit breaker usually employed.

The fuse wire is fastened to a stretched spiral spring, which is released as the wire



The high tension fuse before and after blowing

Arrow indicates fuse blowing on 66,000 volts

melts. Instantly it contracts and draws the fuse wire to the bottom of the fuse, introducing a large gap. The whole fuse works in a non-inflammable liquid, which is directed into the gap as the parts draw apart, smothering the tendency to arc. The speed of operation is said to be less than 2/100 of a second, so that if an arc starts, it is soon checked.

Steel Tape Winds Phonograph and Saves Work



ANNOYED by the drudgery of continually winding his phonograph, Allen D. Howarth of Brooklyn, New York, invented a steel tape which would replace the crank. He mounted a sprocket, about four inches in diameter on the end of the shaft, and passed steel tape about it. One pull of the steel tape equals four turns of a crank.

Hay for Cattle Sorted and Analyzed

THAT baled hay can be scientifically and quickly analyzed, to determine its food value before it is fed to live stock, has been proved by H. H. McClure, hay specialist of the Department of Agriculture. His invention of a sorting table with six compartments enables inspectors to separate the various kinds of grass of which a bale of hay is composed and to grade them according to their amount of nutritive value.

The hay is examined in a sliding sample tray with a wire mesh bottom placed on top of the desk, so that dirt and fine material sift through into a separate compartment. The moisture content of the hay is determined by heating a sample in an electric oven placed close to the table.

In grading the hay, the inspector first examines the bale under a strong light to



form an opinion of its quality as a whole. Weighed samples are then sorted on the table, where the percentage of weeds and inferior grasses, the color, texture, condition, maturity, and excellence of curing are determined. A final value for the hay is based on all these factors.

The government's laboratory for hay standardization is at Alexandria, Virginia.



Armless Sharpshooter Uses Teeth to Win Matches

LOSS of both arms has not prevented William A. Winemiller, of Spencerville, Ohio, from becoming a crack rifle shot, famous throughout northwestern Ohio as the "armless sharpshooter." He has already won 10 consecutive shooting matches this year.

Winemiller was a deer and bear hunter when a young man. Twelve years ago his right arm was severed near the shoulder, and his left arm between elbow and wrist. Now he uses a special rifle, very light in weight, which he balances on the stub of his left forearm. He fires the rifle with his teeth by means of a small wire leading from the trigger to a rubber plug held in his mouth. In his last match a 50-cent piece would cover the holes made by 10 shots fired at 50 yards.

Automobiles on the Farm

EVERY third farm in the United States has at least one automobile; but only one farm in 28 has a tractor, and only one in 50 a truck.

Since only 40 per cent of farms have telephone connections, the auto seems the most desired adjunct to rural life. Even now only one farm in 10 has water piped into the house, according to the report of the United States Census Bureau.

"A Motorcycle for Cost and an Auto for Comfort"

CLAIMING to be "a motorcycle for cost and an automobile for comfort," a new vehicle combines the two wheels and handlebars of the former with the chassis and spring suspension of the latter. The result is a light, fast means of motor transport for one person.

The front axle, shaped like an arch, does away with danger of breakage by applying the thrust load on the center line. This feature enabled the designer to build the front fender broad enough to keep wind and dust off the rider.

The rest of the chassis is exactly like that of a tiny automobile, with all machinery



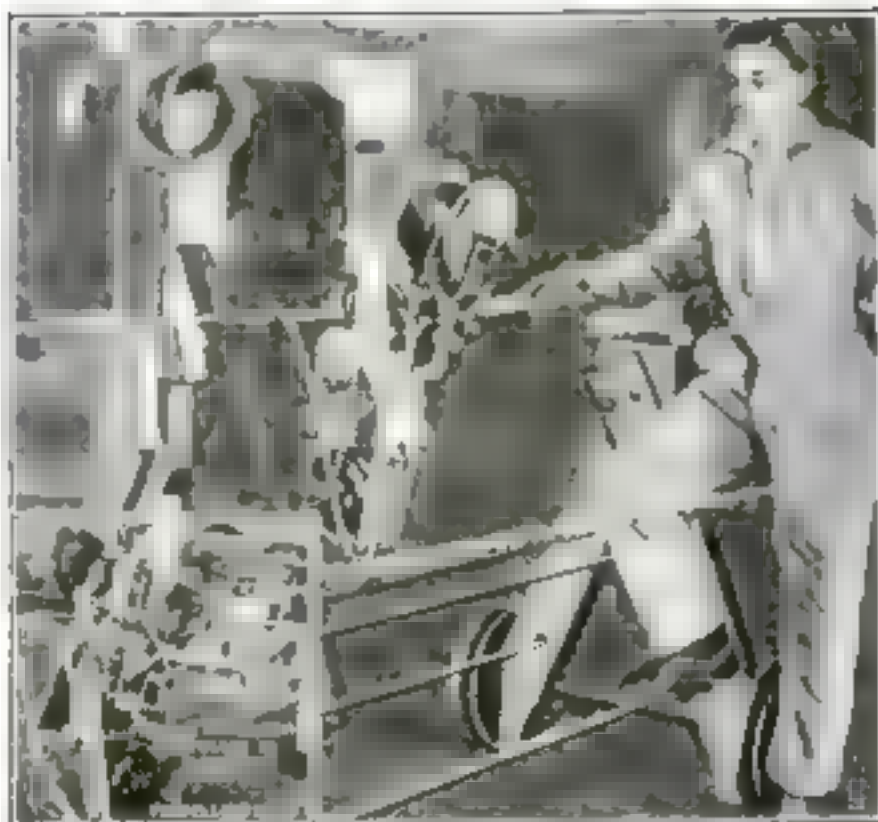
Automobile-like chassis, spring suspension, and enclosed machinery are shown in the motorcycle above

enclosed. With the center of gravity below the hubs of the wheels, the vehicle can be kept upright more easily, it is said, than the average motorcycle. The chain drive and methods of manual control have been adopted from the motorcycle.

Electric Winder Binds Wire Cable

A NEW electrical machine that winds tarred twine around wire cables to protect them from rust consists of a movable frame that pulls itself along the cable, and a rotating mechanism that winds, or "serves," the twine tightly at the rate of three feet a minute. This is faster than 12 experienced men can do an equally perfect job.

The tarred twine is fed by four steel fingers from a reel to a rotating winding head centered on the cable and driven by a chain drive from a small electric motor. The reel is carried around with the winder, but the steel frame supporting the motor and switch hangs steadily from the cable. Springs on the rollers feeding the twine keep it at the necessary constant tension. Machines of



Pulling itself along the cable, the mechanism described in the inset winds the twine at the rate of three feet a minute

this sort are now in use in the Navy Yard at Puget Sound, Wash.

Small Log Pierces Tree without Shattering



SLIPPING down a steep mountainside recently near Slate Run, Pa., a 4-inch log drove through a 12-inch tree like a cannon-ball, suggesting that momentum, rather than hardness, is the great factor in penetration.

The small log struck the tree a blow of 30,000 foot pounds—equal to the impact of 16 tons falling one foot. This is calculated on the basis that the log weighed half a ton, and gathered a speed of 20 miles an hour in its course down the mountainside.

Paper Your Own Walls with an Automatic Machine

A HAND-OPERATED wallpaper machine that automatically performs the technical details of papering has been invented by Stanley Pytlak, of McMechen, W. Va.

The roll of wallpaper is placed in a metal cylinder, from which it is unrolled by the turning of a crank. As the paper emerges, the side next the wall is automatically covered with paste by a rotary brush fed from a small paste tank, while a similar dry



As the paper unrolls, brushes paste it and press it down

brush on the outside of the paper presses it smoothly against the wall. The operator moves the machine down the wall by hand, keeping one end in contact with a straight edge and spreading the strips of paper evenly and quickly.



Electric Phonograph Music for Broadcasting

ELECTRICAL reproduction of phonograph records by a device that eliminates the horn and gives the listener complete control of the volume of sound, has recently been perfected by E. T. Jones, of New Orleans. His invention consists of a coil close to the phonograph reproducer, the vibrations of which are said to set up feeble currents. These currents are led to head phones, where the music is faithfully reproduced.

With a small amplifying set introduced into the circuit, the volume of sound can be controlled by turning a thumb-screw. In one test, a dictaphone operator was able to transcribe a wax cylinder although the man who dictated had not talked loud enough to make a fair cut in the wax. With a loud speaker, any talking device can be heard without head phones.

Since by the invention the music is converted into an electric current, the instrument permits the sending of phonograph music directly over radio broadcasting sets, the inventor claims. This may result in clearer music at receiving stations.

Goggles Add Perspective to Motion Pictures

GOGGLES that give moving pictures perspective and depth, and at the same time enable the spectator to see the pictures in any general color he thinks the action requires, have just been invented in Europe. Three colors are usually sup-



Green, blue, and red color effects are obtained by use of these glasses

plied—green for outdoor scenes, blue for the night close-ups, and red for fires.

The device works on the principle of the stereopticon. Each eye sees the movie through two lenses placed some distance apart. Although there is but one film on the screen, the pictures are said to have been taken in such a way that when viewed through the two glasses the scenes appear to be in three dimensions.

FOR anything you want to know about radio, write to
POPULAR SCIENCE MONTHLY'S Information Department.

A Super-Junkyard for Battleships

Torches Cut 18-Inch Steel Armor into Five-Foot Lengths and Giant Shears Snip Destroyers Apart in Newest Industry

THE greatest junk business in the history of the world sprang up almost overnight when the recent Conference for the Limitation of Armaments, in binding the United States, Great Britain, France, Italy, and Japan to "keep the peace," decided to discard more than 2,000,000 tons of fighting ships of three leading powers.

In the United States a brand new industry was created—that of scrapping or converting 845,000 tons from the vessels of Uncle Sam's navy. This displacement tonnage represents about 300,000 tons of steel and 4000 tons of scrap valued at millions of dollars.

The gigantic task of literally sawing apart the heavy steel armor of modern fighting ships has called for methods entirely new. Sledge and cold chisel are tools of the past. In their place are the sawlike flames of oxyacetylene torches that rip the toughest steel armor plate, from 10 to 18 inches thick, into five-foot lengths, as if they were boards in a sawmill, and 10-ton crocodile shears that snip through six-inch destroyer armor like paper.

How Ships Are Torn Apart

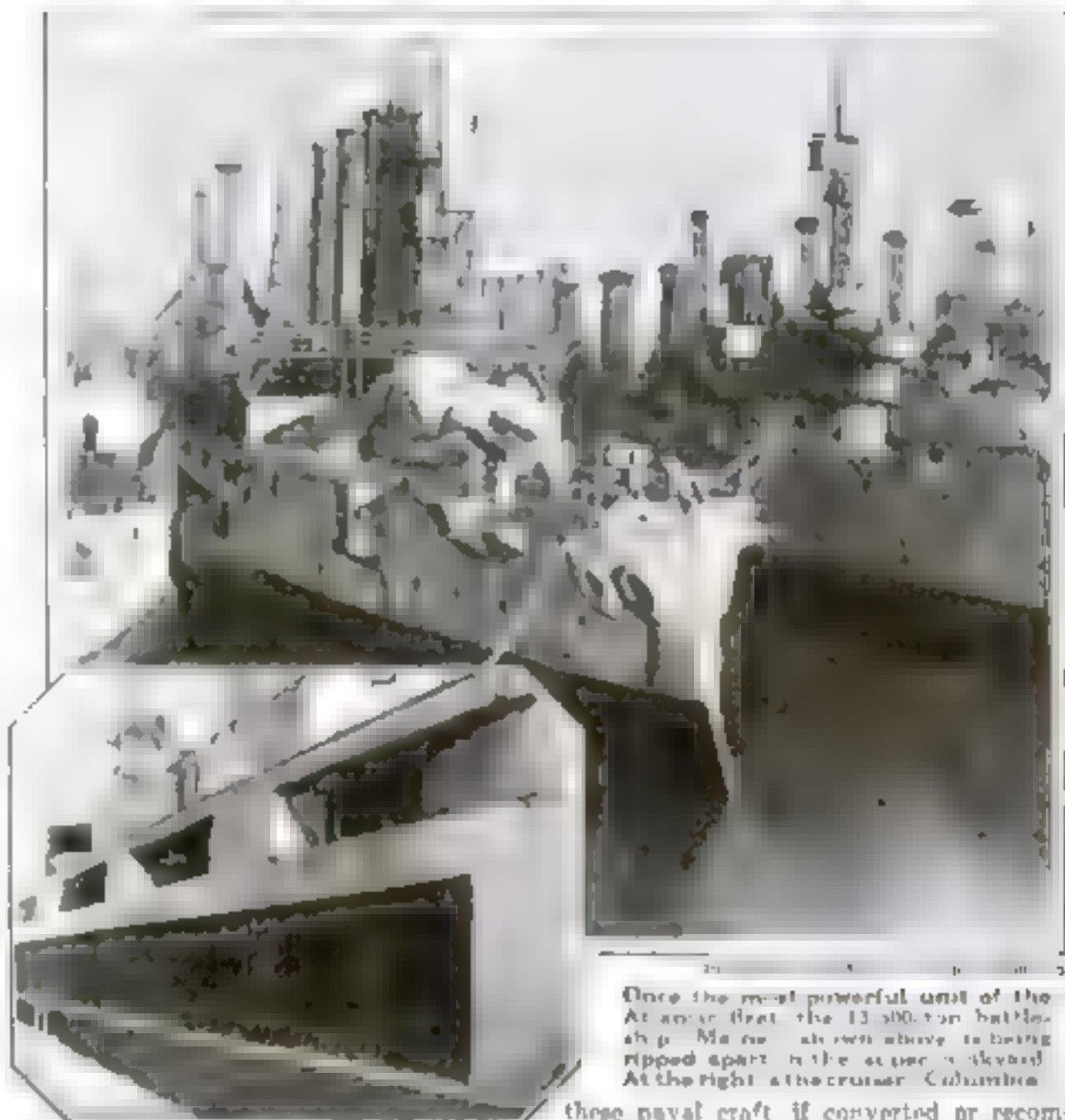
Consider how the intricate structure of a battleship is put together, plate by plate and rivet by rivet—a task that requires years to complete—and you may realize the tremendous task that confronts the modern super-junkman. Piece by piece, the massive fabric must be torn apart, in reverse order, beginning with fighting masts, then the superstructure, the armored hull, and finally the keel itself.

This new industry is interestingly exemplified in the yards of the Henry A. Hiltner's Sons Company of Philadelphia, who are the successful bidders for a colossal proportion of the 845,000 tons that the United States must scrap or convert. Tied to these docks today is a navy greater than that of Italy at the beginning of the war, or of the United States in 1910.

You cannot casually call in a passing junkman and sell him a 13,500-ton battleship of the *Maine* type. Nor can you tell the small boy of the family to load the 411-foot cruiser *Columbia*, formerly flagship of the Atlantic fleet, on his little express wagon and take it to the "ol' iron" man and sell it.

The Philadelphia company bought these, and many more, ranging from battleships and cruisers down through the list that includes the monitors *Monterey*, *Oriskany*, and *Tonopah*, torpedo boat destroyers, coast torpedo boats, Eagle boats whose names are just numbers, and finally reaching the tiny submarine *A-1 Plunger*, which was the grandfather of the present-day S-41 type of submarine cruiser.

Under the terms of the sale,



Once the most powerful unit of the Atlantic fleet, the 13,500-ton battleship *Maine* shown above is being ripped apart in the super-junkyard. At the right the cruiser *Columbia*.

How the watertight belt of 11-inch hull armor is cut away is shown in this close-up view of the battleship *Maine*. Above the armor belt note the barbette emptied of their six-inch rifles.

these naval craft if converted or recommissioned, may not pass from American registry of ownership, and their armament from one-pound quick-firers to the huge 12-inch rifled cannon on the battleships, must be disintegrated by burning and then cut up into five-foot lengths.

The 13,500-ton *Maine* presents a concrete example of the dismantling and reforging into peaceful plowshares of a battleship that was once the most powerful unit of the Atlantic fleet. The steel hull of this monster weighs about 25 per cent of the 13,500 tons displacement; 25 per cent is armor plate, and the balance of nearly 8000 tons is propelling machinery, armament, ammunition, fuel, and general machinery.

Armor Plate Cut into Blocks

The armor plate is first taken off the inside shell in pieces weighing from 25 to 40 tons, and swung to an upright position in the yard, where the pieces are cut with oxyacetylene torches into two by five foot blocks that may be readily fed into charging boxes of open-hearth furnaces. Because of the valuable alloy content of nickel steel, this is



Tiny granddaddy of all successful submarines, the Holland "A-1 Plunger" is being scrapped on the deck of the partially dismantled monitor "Puritan."

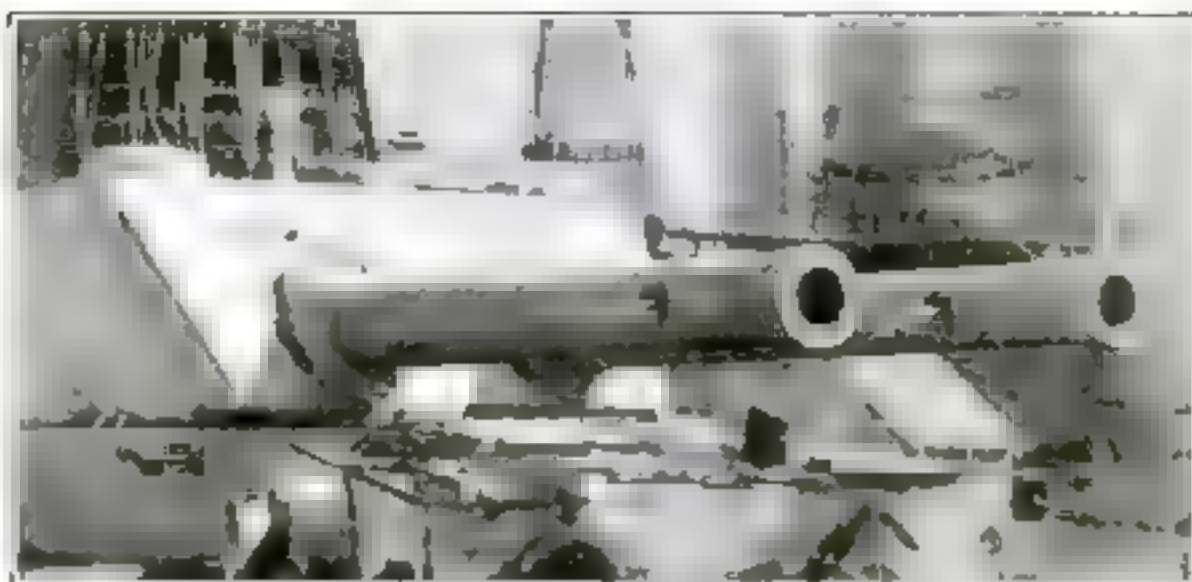
one of the most desirable by products, as it is chiefly used by the automobile industry and for special uses when reformed.

The almost human machinery that operated gun turrets, ammunition hoists, refrigerating systems, and other intricate nerve centers of the floating fortress, is broken up into small pieces that a single workman can readily handle by the use of stone pile-drivers with a striking impact of 100 tons. This small scrap is purchased principally by the gray-iron foundries and treated in combination with low grade iron ore, later appearing, recreated, in the frames of harvesting and other agricultural machinery, engine bases and similar low tensile strength iron products.

Junk of Greatest Value

The most precious "junk" is the copper, gun metal, navy brass, manganese bronze, lead, zinc, and navy composition that are assorted into their different grades, melted by the smelters into ingot form and sold to manufacturers of practically everything in the metal trade. Some of the equipment from the *Mower* will take form in new ship castings, steam pumps, and propellers.

Not all of the hulls of these former fighting craft will be broken up. Many will be converted, as in the case of the torpedo boats *Truxton*, *Worden*, and *Whipple*. Re-engined with kerosene-oil burners, these former destroyers are now carrying fruit out of Central America to the United States. Because of the speed these clean-lined grayhounds of the sea can attain with comparatively low powered equipment and their seaworthy qualities, expensive refrigeration machinery has been found unnecessary. In addition they are very economical, saving lightering cost, because of their light draft and ability



Arrows point to holes burned through 13-inch guns in the main battery of the battleship "*Wisconsin*" to prevent possibility of their use as deadly weapons.



With this machine to guide the oxyacetylene torch, the workman makes a clean, straight cut through a 25-ton strip of 11-inch hull armor, sawing it into five-foot lengths. The torch is moved by the mechanism along a chalk line.

to go up shallow rivers on high tide and lay off plantation wharfs for loading.

When not so converted, the destroyers already purchased by the Philadelphia firm and they number 50 former menaces to Germany as submarines - are ripped apart with powerful chisels operated by compressed-air devices. These pieces are melted and rolled into various shapes for structural steel, rails and sheet plate.

Old Troopships Are Valuable

Former English troopships that saw long service in the Indian seas, *H.M.S. Malabar* and *Holapur*, are lying in the berths where the international cup defender *Columbia* and Admiral Farragut's old flagship *Franklin* once lay when these ships, together with the *Jamestown*, *Saries*, and *Keystone State*, were previously wrecked by the *Hitlers*. The old troopships are very valuable from the standpoint of "scrap," being constructed of the purest wrought iron that is convertible into staybolts, etc.

Golfers Drive over Indoor Bunkers

A NINE-HOLE golf course has recently been installed in a department store in Portland, Ore.

The length of the fairways varies from five to 25 feet, but the putter is not the only club used in the indoor game. To play the "bunker hole," for example, you must drive from a tee over a high bunker and into a net

beyond. To clear the bunker, the ball must be driven with a force that would send it 200 yards on an outdoor links.

The course was built by laying boards over three inches of undulating earth spread on the floor. On the fairways, this earth is covered with boards and canvas, while the "rough" is represented by real turf.



Real turf is used for "the rough" in this nine-hole course, while the fairways are of boards laid over three inches of earth. This miniature golf course is laid out in a Portland, Ore., store.

Adjustable Creeper Gives Comfort



YOU can work comfortably on the flat of your back under the car, if you lie on a garage creeper with a headrest that you can raise or lower by pulling a hand lever.

The end of the creeper consists of a padded cushion about six inches wide, supported by two pairs of flat steel bars, pivoted in their centers, with their lower ends sliding on two round bars extending across the creeper beneath the frame. When the hand lever is pulled, the lower ends of the bars are forced together, raising the headrest. The lever can be locked in any position, leaving both hands free.

NATURAL soaps are found in the root of the Spanish soap root, the soap berry of Chile, South America, and the bark of the soap tree of Peru, South America.

Canvas Doors Form Movie "Prison"



The movie's new method of creating the appearance of a long vista in small space by erecting a series of arched canvas doorways is shown above. At the left is the corridor scene thus produced as it looks on the screen.

The method is to erect a series of canvas partitions with an arched doorway cut in each. The height and width of the doorways diminish as the distance from the camera increases. This gives the movie a perspective of a long vista in a long corridor.

Though the corridor as it appears on the screen seems at least sixty feet long, the length of the row of doorways is really less than 20 feet and a great reduction is effected in the studio space needed to film the set. The inventor of this method has already saved the moving-picture company many thousands of dollars.

WHAT the audience of a motion-picture show sees as a long jail corridor is in reality only a series of arched doorways made of canvas. By an entirely new system of forced perspective a well known producing company has succeeded in producing the effect of a large building with the minimum amount of construction.

Fountain-Pen Is Its Own Check Protector

YOU can now prevent your checks from being raised by using a newly invented fountain-pen equipped with a sharp steel wheel, mounted in the base, which shreds the fibers of the paper and forces in a red, acid-proof ink. This protects the amount and payee's name just as they are safeguarded by a mechanical check protector.

When not in use, the check protecting feature is covered by a hard rubber cap.

The ink used on the protecting wheel is



Would You Row without a Backache?

A BACK rest that converts an oak thwart of a boat into an armchair has recently been invented by Messrs. Polhamus and Gillette, of Los Angeles, Calif. While the oarsman is rowing, a spring in the metal frame holds the rest constantly against his back.

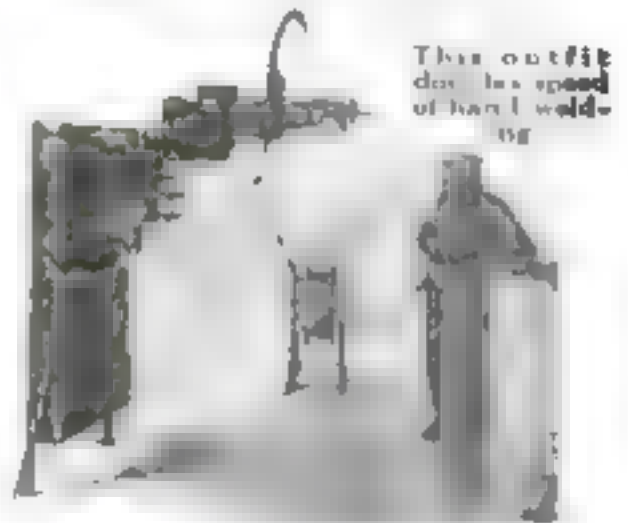
The device folds so that it may be carried under a person's arm, and it will convert an old log, a plank, or a rough stone into a comfortable chair.

Radio and Lightning

"HOW will lightning affect my radio set? Is there danger to my home during summer thunder showers?"

Thousands of new wireless fans, worried by these questions, have recently become more interested than ever in the whole subject of lightning. Dr. Charles P. Steinmetz, the recent creator of "laboratory lightning," and a lifelong student of the vagaries and secrets of the real thing, relates his latest discoveries, in an article for the next issue of **POPULAR SCIENCE MONTHLY**, which will interest radio fan and general reader alike.

Semi-Automatic Welder Seals Uneven Seams



A NEWLY perfected semi-automatic welder is said to double the speed of the hand-operated welder, while retaining the continuous features of the full automatic machine. It allows the operator to direct the arc and is designed for welding products where the seam is of irregular contour, or the work too large to permit the use of the automatic machine.

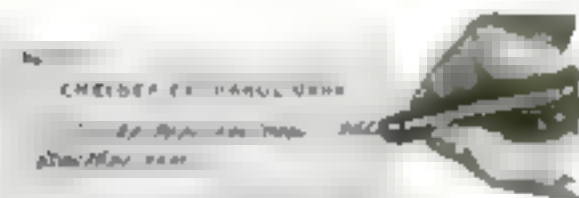
The new electric apparatus consists of a welding tool resembling an automatic pistol connected with a flexible wire guide for the electrode wire, and containing a switch that controls the panel of the automatic welder.

Carry Your Checker Board in a Pocket Roll

A CHECKER board printed on a rubberized fabric that can be rolled up and carried in the pocket enables the enthusiast to enjoy his favorite game anywhere he may happen to be.



When rolled, this rubber checker-board becomes a case for the counters.



How the small cutting wheel shreds and inks the paper of the check

thick, much like printer's ink, so that no reservoir other than a small felt pad is necessary. To this a drop of ink is applied with the end of a match once or twice a year. The ink pad is built into the cap of the pen.

Metal Balloons May Draw Power from Sky

Collecting Atmospheric Energy with Metallic Bags, Experimenter Claims to Have Found a Way to Utilize "Free Electricity"

By P. J. Riedon

WILL the vast reservoirs of dormant energy, represented by the difference in potential between the atmosphere and the earth, be harnessed at last and utilized to light and heat our homes and to turn the wheels of our factories?

The limitless supply of potential energy all about us has long been recognized. Many electrical engineers have sought in vain for satisfactory means of harnessing it. Recently, however, M. H. Plauson of the Traun Research Laboratory in Hamburg, Germany, has devised a scheme for utilizing this free electrical energy—a method that may be described as power transmission by waves through the ether, on much the same principle as wireless telegraphy and telephony.

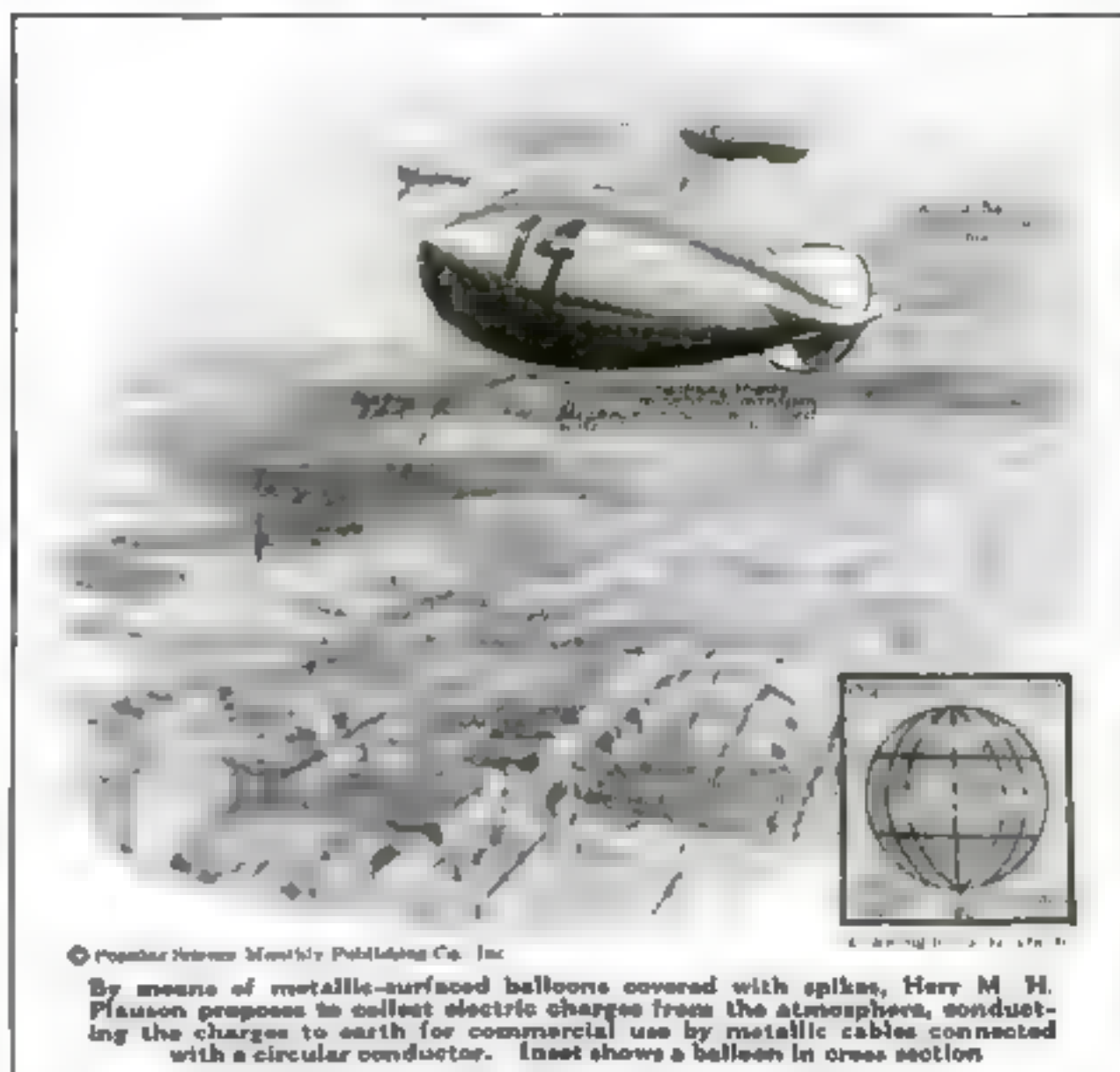
Spikes Cover Balloon Surface

Plauson makes use of a number of balloons with metallic surfaces covered with spikes. These balloons are sent up to a height of several thousand feet. The charge is conducted to earth by a metallic cable attached to each balloon, all the cables being connected with a circular conductor leading to the power stations.

By means of special transformers (details of which are not yet available), atmospheric charges are converted into electromagnetic vibrations of the ether. These vibrations are so powerful that they operate motors attuned to respond to them, in the same way—but of course on a far more powerful scale—that one tuning fork when struck will cause another exactly similar tuning fork to vibrate.

The lightning flash, always suggesting tremendous power, has long tempted experimenters to extract power from atmospheric electricity. In the year 1753, Benjamin Franklin experimented with a kite with a wet string and succeeded in conducting electricity to the ground and charging condensers with it. Afterward, by the use of a metallic string, electricity was drawn from the atmosphere, producing sparks nine feet long.

The difference in potential is due to charges of static electricity, which are believed to be positive in relation to the



earth. It is something like the positive and negative charges on the plates of a charged condenser.

But although a charge may be conducted to earth, or reach the earth from a cloud with a flash that we call lightning, it is not the same thing as a current of electricity and cannot be used to drive electric motors directly as a current can. The explanation is simply that the current from a dynamo is generated and used at a certain predetermined rate, while in a static atmospheric charge there is a large amount of electricity, at a very high potential difference, that endeavors to reach the earth all at once. When we consider that a current of 10,000 volts is necessary to spark across a one-eighth-inch gap, it is easy to

appreciate what an enormous potential difference there must be for a charge to produce the length of spark through air that we see as a flash of lightning.

Early experiments with atmospheric electricity, whether with kites like Franklin's or by means of metallic rods projecting high into the air (such as that used by Richmann in 1753, which killed the experimenter by a great discharge), were made more especially when thunderstorms were imminent. Plauson, however, does not propose to wait for these conditions, which arise from accumulations of electricity on minute particles of moisture in the air, that collect locally and thus set up such a powerful influence that the charge breaks through the resistance of the lower strata of air and flashes to earth.

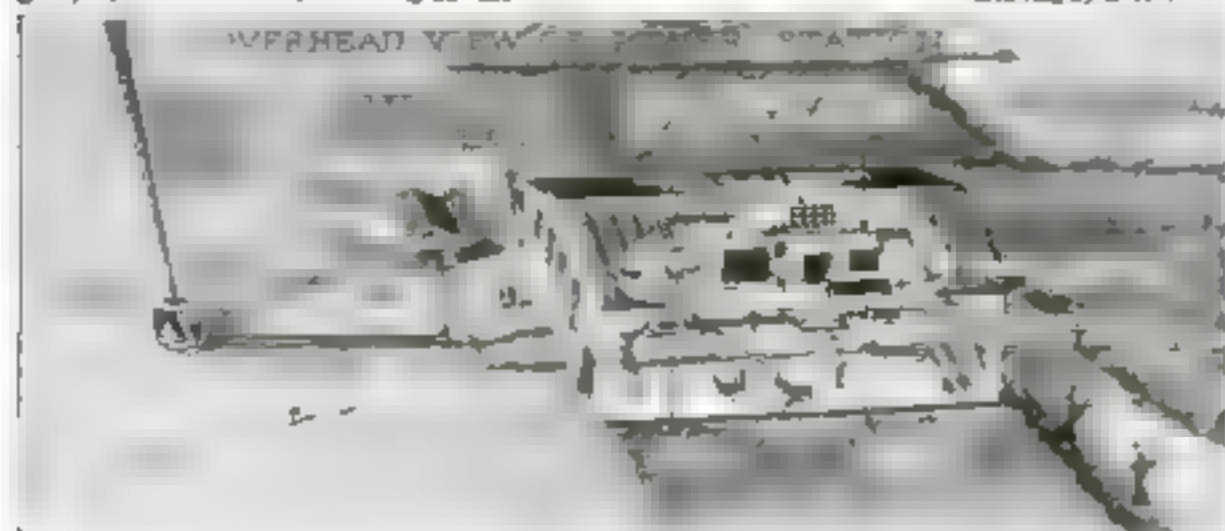
Would Prevent Thunderstorms

Plauson's idea is to take advantage of the average difference of potential, by which means he believes that thunderstorms will actually be prevented in given localities where his apparatus is at work on a big enough scale, by maintaining a condition of local equilibrium and thus preventing the accumulations that are necessary before lightning can occur. Whether he is right or not in his forecast can, of course, only be proved by experiment.

Up to the present his method has not been tested on a large scale, but he claims that, with two balloons at a height of 1000 feet, he obtained power equal to 81 1/4 kilowatt hours a day.

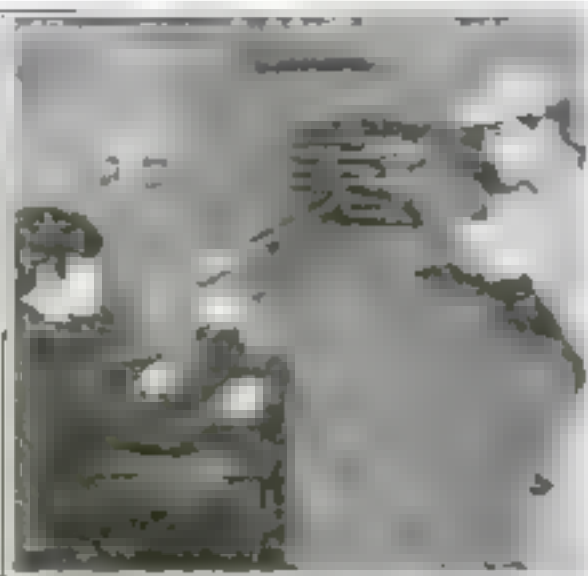
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Drawing by G. H. Davis



Atmospheric charges conveyed to the power station through the steel cable at the left are transformed into electromagnetic vibrations of the ether, which, in turn, operate motors.

Gas Pistol Stops Fire or Thief



YOU can stop either a fire or a burglar with a recently invented gas pistol consisting of a small cylinder filled with compressed gas, and slipped onto a pistol grip handle. The pistol is discharged by simply pulling a trigger. This releases a pin, which punctures the container.

The gas, released, flies out in a dense cloud under its own pressure, enveloping the fire or suffocating the intruder, as

the case may be. No gas is released toward the rear, so that a person may fire the pistol without wearing a gas mask.

The gas is said to have much the same effect on a burglar as tear gas; for while it will incapacitate him for a short time, it will do him no permanent injury.

On a fire, the gas acts like the carbonic acid gas of the usual extinguisher, smothering the flames.

Arm for Street Car Forms a "Safety Zone"

PROJECTING arms which are extended from the rear of a street-car at stopping-points will afford passengers descending from the cars real protection, if the invention of Col. Charles Gore of Los Angeles, Calif., is adopted. Many accidents have already been prevented by the present "safety zones," although these depend on automobile drivers' knowledge of and obedience to traffic rules.

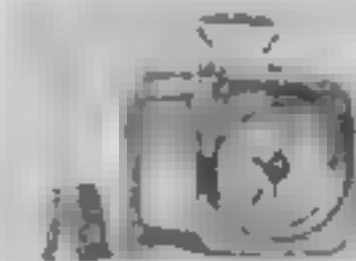
Colonel Gore's device is a telescoping bar that is automatically extended as the



How the telescoping arm protects passengers

motorman cuts off the power preliminary to a stop. It remains extended until the car is ready to start again. The bar is extended and retracted by compressed air.

In addition to forming a safety zone wherever it may be necessary—whether this be at the usual street crossings or not—the bar prevents women and children from walking around the rear of the car the wrong way. This, too, has been the cause of many accidents. The bar also enables the car to be loaded more quickly, as it eliminates jamming in the doorway by forcing the crowd to form in line.

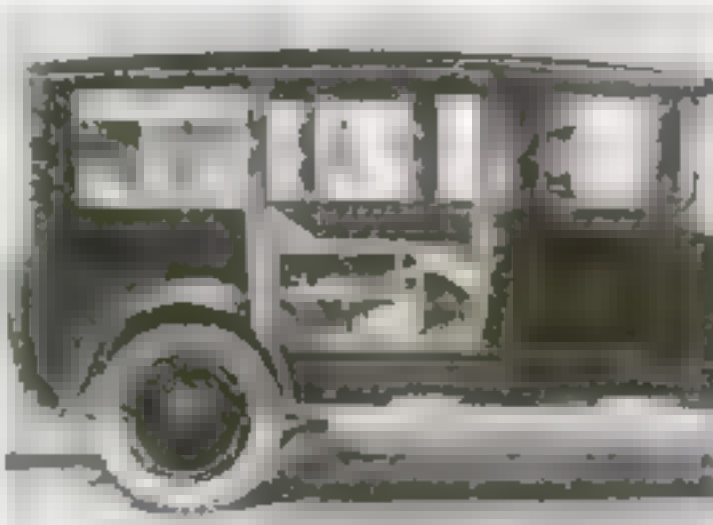


Doll-Sized Alarm Clock Rings Tiny Gong

TINY alarm clocks, measuring 1 1/4 inches square, are the latest novelties to appear on the market.

One handle winds both the time and alarm springs, while the entire case forms the gong for the alarm. The clock is constructed on practically the same principle as the familiar alarm watches.

Limousine Is Converted into an Ambulance



FOR the use of institutions that desire to economize by combining an ambulance and a palatial coach in a single vehicle, a limousine has been constructed that may be converted at will from one to another of these uses.

Sticking Machine Seals Envelopes Securely

IN A new type of envelope sealer, the envelopes to be sealed are stacked with their flaps down and toward the front of the machine. Then a thin brass plate moves up as a hand wheel is turned and, sliding in between the envelope and its flap, moves the envelope ahead. After it has moved a certain distance, another sheet of brass presses it against a moist felt under the top



Envelopes are sealed and stacked by turning a crank

brass, thus insuring a uniform moistening of the gum.

The upper brass now moves still farther forward and at the same time a pair of rubber rolls open to receive the envelope. As it enters them, they come together tightly and apply the pressure necessary to insure the flap sticking firmly.

A guard in front of the rolls keeps the envelopes right side up and guides them to the rack in which they are stacked.

The moving parts of the machine consist of two gear wheels, the two rolls and three sets of cams with their attachments.

Rustless Iron Holds Polish

IRON that will not rust has recently been produced in Sheffield, England. The new product is said to be superior to the so-called stainless or rustless steel, since it is rustless in the ordinary state, and does not require heat treatment.

It can be worked in the cold, soft state by all mechanical processes, and after being polished becomes rustless. It seems to remain so indefinitely. In tests after protracted exposure to the fume laden air of industrial centers, the polish on the metal was as bright as the day it left the mill.

Queer Science Stops Pain by Pressure

Pinching Fingers Deadens Toothache, while Rubber Band on a Toe Will Ease Smashed Thumb, Says "Zone Therapy" Expert

By Ralph R. Perry

HAVE you ever, after accidentally pounding your thumb, seized it and held it tight to stop the pain?

Do you know that when you did this, you were unconsciously applying one of the secrets of an extraordinary medical discovery of the day, called "zone therapy"? This queer new method of preventing suffering in one part of the body by mere pressure on another part is said to have such astonishing results, and to be so easily applied by any layman to his own body, that the whole subject may seem, at first glance, a scientific absurdity.

Zone Theory Is Demonstrated

And yet, actual demonstration of the zone therapy theory—proof that a toothache, for example, can be stopped by squeezing one of your fingers or corresponding toe—is credited to a physician in Hartford, Conn.—Dr. William H. Fitzgerald—by other prominent medical men.

If you experiment with Doctor Fitzgerald's remarkable zone therapy system, you may find, among other things, that you can

Cure a headache by pushing on the roof of your mouth

Relieve an aching first or second molar by pressing firmly the knuckles of your second finger, and the wisdom tooth by pressing firmly the corresponding sections of the third and fourth fingers.

Stop the pain of a sprained right knee by pressing your right elbow

Relieve the hurt in your left thumb that you hit with a hammer by binding a tight elastic band around your left large toe.

In fact, according to the exponents of zone therapy, a pain in practically any member of your



As proof that pressure on one part of the body will prevent pain in many other parts, Doctor Fitzgerald shows this photograph of a patient who, after pressure on the dental nerve of the left lower jaw, felt no sensation of pain from the stickpins in her left arm, hand, and chin

body may be partially or entirely put out of business by simple pressure on another member in the same bodily "zone."

To the layman who succeeds with it, this mysterious method may bring greatly needed relief when troublesome aches and



Miles from medical aid, the camper understanding zone therapy may ease the pain of a sprained left knee by firmly pressing his left elbow in the same "zone"

pains threaten to spoil a summer vacation; when a camping accident to knee or ankle occurs deep in the woods, miles from medical aid. But it may be just as comforting when applied in the endless emergencies of city life

Doctor Fitzgerald has discovered that the instinctive habit of pressing firmly on any part of the body that hurts is entirely scientific, and that by observing a few

simple rules which he outlines you can often eliminate pain entirely. The layman may apply zone therapy to himself without danger. Usually, it is beneficial; in any case, it is harmless.

How Zones Divide the Body

"Zone therapy" is the name applied to the method, because Doctor Fitzgerald has found that for purposes of relieving pain the body may be divided into 10 vertical zones, five on each side of a center line. The extremities of the zone division lines are the fingers and toes. For example, the first zone on either side of the body begins at the big toe and runs up the entire body, including the chest, back, and head, extending down the arm and ending at the thumb. The second, third, fourth, and fifth zones originate similarly in the first, middle, ring, and little fingers and run to the corresponding toes.

Here are some of Doctor Fitzgerald's conclusions, based on the zone theory:

Pressure across any section in anterior half of any zone will relieve pain in any other part of that half of the zone, and pressure across any section in posterior half of any zone will effect the same relief in that zone, although pressure at some points is more effective than at others. An important point to bear in mind is that it will do no good to squeeze your right toe to reduce pain in your left thumb; or to press upon the first finger to cure an injury that should be treated by pressure on the second finger. Areas of pain run up and down, and also crosswise, as from the various orifices of the body.

In each zone, the finger corresponds with the toe, the wrist with the ankle, and the knee with the elbow. Therefore, wherever the pain may be, choose the corresponding member in the upper or lower part of the body and press firmly at some point where the main trunk nerves are close to the surface—that is, at the joints, where there is little flesh and muscle over the bones.

Rubber Bands May Be Used

The best way to apply zone therapy to yourself, Doctor Fitzgerald advises, is to use rubber bands passed entirely around the proper finger or toe, so as to include every part of the zone, and thus necessarily reach the right spot. Doctor Fitzgerald himself uses a "therapy zone" or spiral spring, for that purpose, but he declares a rubber band, or even a tight bandage, is often as effective. He outlines the

method as follows:

Slip on a rubber band that is uncomfortably tight, and leave it in place for from five to 15 minutes. Since this will stop the circulation, always remove it before the end of the finger starts to become blue, and then, if the pain continues, place it on again, repeating the operation several times a day for several minutes if necessary.

The continued pressure has been found



Beginning at the front of the jaw, an ache in any one of the first three teeth on either side is controlled by pressure on the thumb on the corresponding side, the next two teeth by the forefinger; the next two molar teeth by the second finger and the wisdom tooth by the third and fourth fingers

to keep the pain from returning, and in many cases of headache or toothache, to cure the affliction. If the pain returns, apply the tight band again, and if it should persist, call a doctor. Recurrent pain that cannot be assuaged by zone therapy, it is pointed out, indicates a genuine pathological condition, and requires the immediate attention of a physician.

Since zone therapy in the hands of the layman is primarily a method of first aid, Doctor FitzGerald suggests the following methods of treatment for accidents that may occur when you are on your vacation, or out of reach of competent medical aid:

To "push a headache out through the top of your head," press your thumb, or, better, some smooth, broad surface like a metal knife handle, firmly against the roof of your mouth, as nearly as possible under the spot where you feel the pain. Hold it in place for from three to five minutes. If the pain is very severe, supplement this treatment by pressure on the joints of the fingers or wrists,



How "therapy rings" are worn on the fingers to block pain on the corresponding side of the body

especially on the top or back of the hand. For a racking headache "just back of the eye," compress the first joints of both forefingers or both forefingers and both middle fingers. This usually gives relief, unless the headache is due to prolonged eye strain or toxic absorption from the bowels.

If a tooth begins to ache, press the cheek immediately over that particular tooth, or squeeze the gums between the thumb and first finger for from one to four minutes. In addition, place a rubber band on the proper finger, remembering that, starting at the center of the mouth and counting toward the rear, the first three teeth on either side are controlled by the thumb, the next two by the forefinger, the next two molar teeth by the middle finger, and the wisdom tooth by both the fourth and little finger of the hand on the corresponding side. Pressure should be applied on the first or second joint. Since the zones sometimes overlap somewhat, it may be best to press upon two fingers.

The best aid in treating other aches and pains incident to a vacation is a blunt pointed aluminum

Pain Zones of the Body



PRESS ON ROOF OF MOUTH TO RELIEVE HEADACHE

TO DEADEN FEELING IN HALF OF JAW AND CORRESPONDING SIDE OF BODY

PRESS ON RIGHT WRIST TO RELIEVE PAIN IN RIGHT ANKLE

PRESS ON RIGHT ANKLE TO RELIEVE PAIN IN RIGHT ELBOW

PRESS ON TOE TO RELIEVE PAIN IN CORRESPONDING FINGER

How zone therapy, for the purposes of relieving pain, divides the body into five vertical zones on each side of a center line, is described in the above diagram. Extremities of the zone division lines are the fingers and toes. The figure is shown anesthetizing the entire left side of body by pressure on the left dental nerve of the lower jaw, as described in the inset above



To locate a pain-relieving spot, press the teeth of a comb on the wrist, then rotate the comb

comb with strong teeth. This enables you to search out and locate the exact spot at which to apply the pressure that relieves the pain of such injuries as a sprained ankle or a wrenched knee. Place the teeth of the comb upon the knuckles, wrist, or elbow as the case may be, and rotate it entirely around the joint, pressing firmly.

You will soon find a spot at which the pain is lessened, and that is the place to adjust your rubber band, or to squeeze with your fingers.

Is it always possible to find such a spot, and if found, will the pain always disappear? Doctor FitzGerald makes no claims so sweeping. Zone therapy, he points out, is no panacea nor cure-all. The reaction of different individuals to it varies greatly. With some persons, pressure therapy produces complete anesthesia, in which minor surgical operations can be performed without the least pain to the patient. With most persons, however, zone therapy produces analgesia—a reduced sensibility to pain.

Doctor FitzGerald's experience is that specialists in zone therapy can deaden sensation in about 80 per

cent of all cases, and can make the nerves quite insensible to pain in about 65 per cent. Among laymen, about half can relieve their own pain, and about 80 per cent can reduce it.

No theoretical explanation of the results obtained by zone therapy has been attempted. The discovery indicates, however, that the relation among the various nerves of sensation is more intimate than physicians have believed. Certain it is that the control centers in the medulla oblongata, at the base of the brain, can be easily stimulated or deadened by proper manipulation at the nerve ends.

Zone therapy, as sometimes interpreted, may depend upon what physicians term "nerve block." As you press upon the nerve over the seat of injury, or upon another nerve that joins the injured one at the brain, you prevent it from transmitting full knowledge of the injury. It is as if the nerves formed a telegraph system, and you were able to cut the wire—producing anesthesia—or to scrape off the insulation, thus reducing the current that is transmitted and



Cross section of finger tip showing nerves between nail and bone. The inset shows points such as this, where bones or knuckles are near the surface, the best places to apply pressure to deaden pain

producing more or less pain insensibility.

Whatever the explanation, Doctor FitzGerald, working entirely by zone therapy, claims to have cured malignant cases of goiter.

"The effect of zone therapy certainly is not due to mental suggestion," says the discoverer, "for if you press the wrong finger, no relief follows, and the method is often effective where mental suggestion fails. Hay fever, for example, can frequently be cured by pressure in the mouth at various points in line with the nose. A sneeze can usually be stopped by pressing the center of the upper lip against the teeth with the first finger. Vomiting and ear sickness—occasionally, even seasickness—will yield to steady pressure or stroking with a metal comb on both surfaces of the hands, in the first and second zones. Lumbago and pains affecting all zones can be helped by pressing on the tips of the fingers, or by grasping a comb so that the prongs press against the middle joints of all the fingers, and the thumb on the comb end. Cross stroking to the median line on extremities or head or body is usually very effective in most pathological conditions, as is also concussion on any part of zone (concussion is not to be limited to the spine).

"The principles of zone therapy are easy to learn. It can do no harm. In sudden emergencies, or when far from a doctor, its use may enable you to save yourself or your best friend from hours of excruciating—and unnecessary—agony."

Corn Fuel Is Cheaper than Coal for Firing Brick Kilns

CORN may be used as a standard fuel in firing the brick kilns of a clay products company at Adel, Iowa. At present prices of corn and coal, more heat can be obtained by burning the corn itself than by selling it and burning the coal it would buy. The practice of burning corn was first undertaken to help the farmer's business by giving him a market for his crop in a bad year, but corn has proved to be such an effective brick making fuel that unless corn rises above 20 cents a bushel, or coal falls below \$10 a ton, the burning of corn is likely to become a common practice in the Middle West.



Instead of the coal pile, the corn pile. Firing brick kilns with corn fuel, as shown above, has saved money for an Iowa clay products company.

Roughly speaking, two tons of corn will give as much heat as one ton of coal, and has about the same caloric value as wood.

coal at \$8 a ton, and at 22 cents a bushel it equals coal at \$15 a ton. Such figures justify the use of corn as a fuel.

Some persons have protested the use of a food as a fuel, but others find it hard to understand why burning corn in a furnace is worse than fermenting it and then burning the alcohol in a tractor, especially when corn worth \$100 as food can give heat equal to \$150 worth of coal.

The relative heating values of corn and coal, as estimated by the United States Department of Agriculture, are as follows:

Corn at 10 cents a bushel equals coal at \$5 a ton, at 16 cents a bushel it equals

Huge Mirror Perfected for Astronomical Use



Polishing the 40-inch surface of the enormous glass dish weighing half a ton.

AMERICAN astronomical observatories will no longer be compelled to buy their best telescopes abroad, for Donald F. Sharp, of Buffalo, N. Y., has succeeded in casting and polishing a 40-inch reflector mirror that weighs half a ton.

Cooling the huge piece of glass with perfect equality throughout is the great difficulty in making such a mirror. If one part cools a single degree faster than another, a strain will be set up in the glass that will distort the image reflected from it. It was not until a special electric furnace was designed to keep the temperature within the limits of one fifth of a degree Centigrade that the casting was successful.

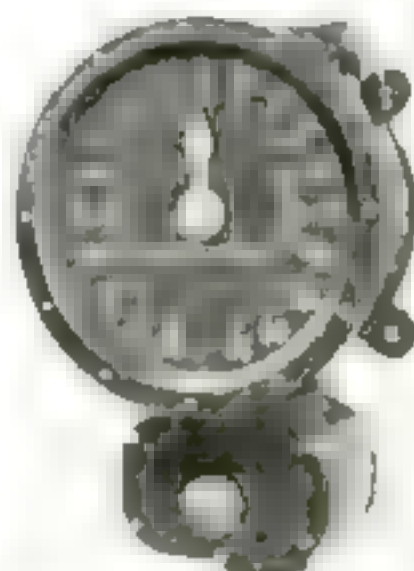
Reflecting telescopes contain no lenses, but obtain their magnification by gigantic mirrors made of heavy disks of glass with a thin coating of metallic silver. The silver is applied to the front surface instead of to the back of the glass, as in ordinary mirrors. The face is carefully ground into the form of a paraboloid. This focuses the light rays in a point, from which a small plane mirror reflects the image to the eyepiece. The disk will be used in a huge telescope now being erected at the University of Arizona.

Rudder Angle Indicator Simplifies Docking

DOCKING a liner without a tug is difficult even for the most skilful pilot unless he has accurate knowledge of the position of the ship's rudder.

With an electric rudder indicator developed by the originators of the gyroscope compass, the position of the helm can be determined to a degree. At the stern of the ship the moving arm of a transmitter is fastened to the rudder stock. As the rudder turns, a segment at the bottom of the moving arm makes contacts with a controller inside the box, so that an electric current is sent over a multi-wire cable to an indicator located near the steering wheel.

The indicator consists of a step-by-step motor that is self synchronizing, and that produces a powerful torque or twisting motion, varying with the intensity of the current. The hand of the indicator is bolted to the shaft of the motor. The contacts in the controller at the stern correspond to every position of the helm between dead ahead and 85 degrees right or left. These are reproduced correctly on the pilot house dial.



Position of the helm is registered in degrees.



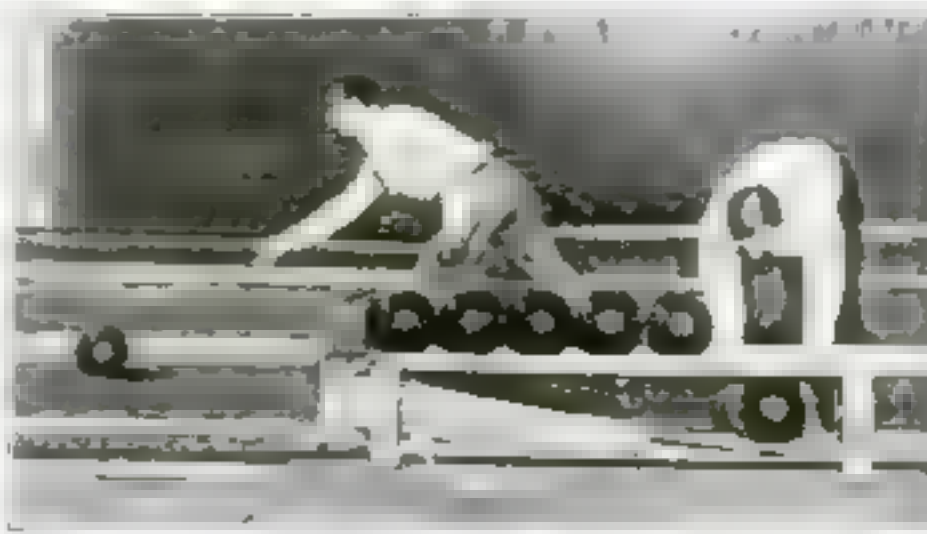
Apron Trap for Balls Saves Bowlers' Temper

AN APRON trap for the bowling alley, to prevent the ball's rolling back from the rack end of the return trough

has recently been invented by Walter Chaiski, of Milwaukee, Wis.

Balls returned to the bowler frequently

do not have sufficient velocity to ascend the incline that delivers them to the storage rack. Sometimes they roll back down the alley. This the new invention obviates by a canvas apron suspended over the trough so that the ball can roll under it, but will be stopped if it starts to roll back.



Returning down the trough to the bowler, the ball rolls under a canvas apron, which checks it from rolling back.

Fantastic Summer House Formed from Mud Pile

WALLS of soft, sticky mud served as building forms in the recent construction of a unique summer house, of irregular and fantastic shape, which not even the builder, a resident of Cincinnati, can duplicate.

The completed house, which appears as if it had come out of some book of fairy tales, is formed of concrete; yet during construction a huge and apparently shapeless mud pile rose on the site.

The foundation was laid three feet below the ground by building a double mud wall very much as a child would build it—by throwing great double handfuls of the place haphazard. From time to time the space between the walls was filled with semi-liquid concrete.

The mud forms, of framework in this manner, were later removed, and the concrete walls, molded by



After the concrete walls had set, the mud molds were dug out and washed away by a hose. The means by which the huge mud pile was built is shown above. The fairylike interior is shown at the right.



Wherever a cavity appeared in the completed summer house, the position of a lump of mud in that part of the mold which prevented cement from forming a smooth wall. Thus the cabin slowly rose from the ground like a mushroom, resembling a gigantic mudpile held in shape by a conglomerate mass of rocks, timber and branches.

The roof, which is reinforced with steel rods, was built in the same fashion. Thousands of mud were used in its construction. Here again the irregular, cave-

like interior was produced by the mud mold, for none of this was added after the house was completed.

After the building was finished, the designer waited two weeks for the concrete to set, and then commenced to dig away his mud mold. He tore away the hardened crust of mud from the exterior, then dug out the interior. Finally by means of a hose, the entire structure was washed clean.

Air Blast Mixes Concrete Evenly in New Automatic Machine

THE problem of mixing the ingredients of concrete in the correct proportions and at the same time so thoroughly as to insure a perfect coating of cement around every particle of sand and every piece of stone has been met successfully by a recently perfected portable mixer in which cement is blown by a fan in a cloud that covers the aggregate.

The output of the new portable machine is from eight to ten cubic yards of concrete per hour. It is a portable machine, and is used in the construction of concrete structures.

and aggregate are simply dumped into their respective troughs and hoppers and the machine does the rest. It continues to work automatically, mixing in the correct proportions, as long as it is kept constantly charged.

At one end of the carriage is a double hopper, into one part of which is delivered sand, and into the other part gravel and stone. At the bottom of the hopper are sliding doors, so designed as to insure the correct proportions of the ingredients. Through these doors the material falls into a

tray the aggregate is mixed, then delivered into elevating buckets on an endless chain. These buckets drop the material to a revolving screen, which sorts the particles so that they fall, separated, down a vertical shaft into a rotating sloping drum. Across the top of the shaft is a horizontal, perforated pipe from which water is sprayed on the falling particles.

On top of the machine is a pair of troughs in which Archimedean screws work. Cement is delivered into one of these troughs (or lime into the other, as the case may be) and is worked by the screws to the other end, where it drops in front of a fan by which it is blown into the upper part of the rotating drum. The cement enters the drum in the form of a dense cloud that effectually coats all the separated particles of the aggregate as they fall.

Material Receives Thorough Coat

As the drum rotates, the mass of material is lifted by angle curbs and drops again and again through the cement cloud, thus insuring a thorough coating of cement. Meantime the mass moves gradually along the sloping drum and finally emerges at the front end of the machine through an opening covered by a hinged door.

The speed of the elevating buckets is variably proportioned to the speed of the screws in the cement troughs, the quantity of water delivered being regulated so that no matter at what speed the machine is working, the proportion of the various ingredients remains the same. The proportion can be varied by altering the gearing. Thus the proportion of cement and aggregate may be varied from one to two to from one to twenty. The makers claim that their cement mixer makes a much stronger concrete than any other method.



When particles of sand and stone carefully mixed in their progress from the double hopper—reach the rotating drum, cement blown into the drum coats each particle thoroughly.

Adjustable Lawnmower Shaves Terraces

GRASS growing on terraces can be cut as easily as that upon the level lawn by using a lawnmower with an adjustable handle, invented by Robert R. Kitchel, of Ridley Park, Pa. Pressure on a toe clip locks the handle at the angle desired. The operator walks on level ground at the foot of

Moving on a turntable, the handle latches at various angles



the terrace, and cuts one longitudinal swath above another on the sloping surface.

The adjustable handle is on a turntable that latches in the central position and at several angles up to a maximum of 30 degrees on each side.

You Can Now Change Tires in a Few Seconds

ONE nut, instead of the usual eight or ten, locks a new demountable rim, invented by H. N. Moody, of New Orleans, to an auto wheel. The tire may be tightened or released almost instantly by means of a locking cam.

To the surface of the felloe are welded 10 metal cleats placed at an angle of 15 degrees. The inside of the demountable rim has 10 projecting lugs, each half an inch in diameter and a quarter of an inch high. When the lugs are wedged into the cleats, the rim is locked securely on the wheel.

The locking is accomplished by a single large cam disk that works between the cam lugs on the rim. One half turn of this master cam releases the tire.



One half turn of a single master cam nut, shown in the inset, releases tire

Fleet to Test Guns on Rag-Manned Gliders



With rag men as pilots, the gliders will be released from navy dirigibles at heights ranging from 3000 to 5000 feet. As they soar downward at a speed of about 45 miles an hour, they will be targets for anti-aircraft guns and small arms of the Atlantic fleet below

GLIDERS manned by dummies will be used to test the anti-aircraft guns of the Atlantic fleet during coming maneuvers off the Virginia capes and Cuba.

During the bombing tests off the Virginia capes last fall, naval officers objected that the tests were not convincing, since aviators would be shot down if they should attempt to approach a modern dreadnaught and launch their bombs as deliberately and from such low altitudes as they did against the anchored German ships.

Dirigibles Will Tow Gliders

To meet these objections, and at the same time give the gunners practice under battle conditions, a fleet of small gliders will be towed by dirigibles, it is reported, and released above the battleships from heights varying between 3000 and 5000 feet. Rag dummies in the place of pilots will be fastened in the gliders to give the marines using small arms a chance to test their marksmanship by picking off "airplane crews."

The gliders will be released in flocks of five, it is announced, and are expected to maintain an average speed of about 45

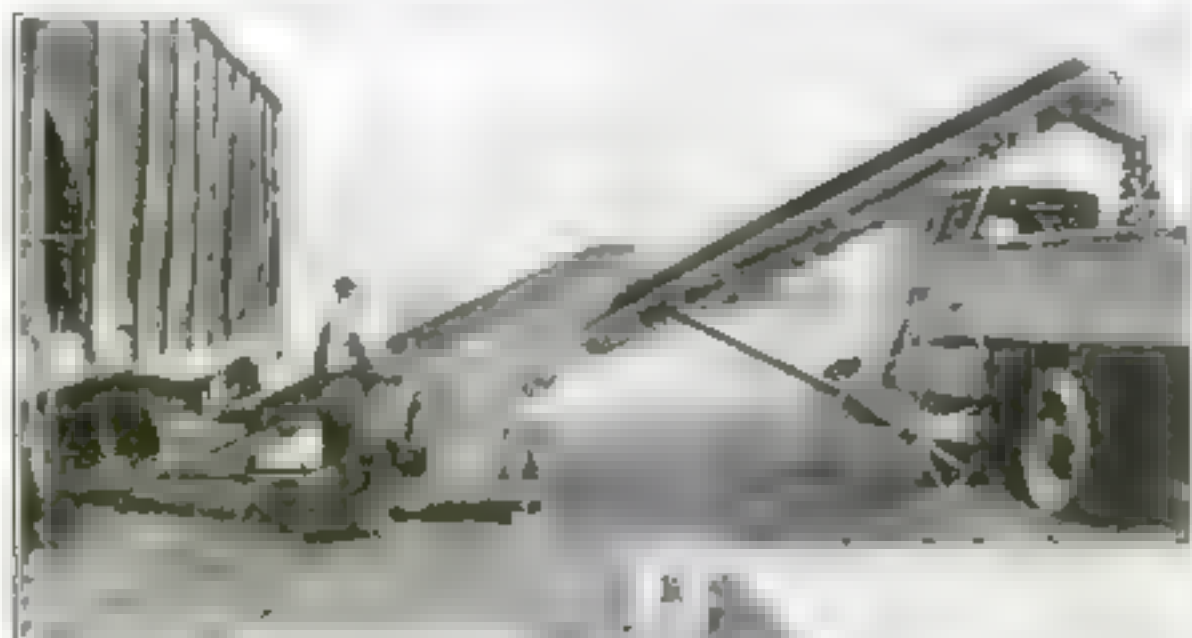
miles an hour as they soar down to the water. This is only about half the speed of bombing planes in full flight, but is more nearly equal to that of the giant bombing planes, carrying 2000- and 4000-pound bombs, which succeeded in sinking the German battleships in the former tests.

The gliders will be much larger than those used in land maneuvers by the army and navy. Each could carry two men with perfect safety, and accordingly they are somewhat larger than the majority of gliders now being built in Germany. If the tests are successful, the results will be valuable not only in determining the value of anti-aircraft gunfire, but in proving that the modern glider can be safely used to descend from the greatest heights.

Practically every ship in the Atlantic fleet, it is said, will take part in the attack on the gliders.

As a special service to readers, the Editor will be glad to supply the names and addresses of manufacturers of devices mentioned in POPULAR SCIENCE MONTHLY.

Belt Lifts Coal from Car to Truck



The flat extension of the unloader, shown at the right, fits between the hopper of the gondola car and the rails. Coal falls from the hopper on a moving belt and is carried up an incline to the dealer's truck.

BY TRANSFERRING 30 tons of coal from the bottom of a gondola car into the coal dealer's trucks in an hour, a newly designed belt-type car unloader is said to enable the small dealer to handle his material as cheaply and efficiently as would be possible in larger scale operation with raised trestle and gravity bins.

Supporting the conveyor in an inclined position is an ingenious framework mounted on the wheels on which the machine is transported.

The machine is wheeled into place beneath the car by one man, who starts a 15-horsepower gasoline motor. As the coal drops from the hopper of the car, it falls on



a moving belt of jointed steel plates that carries it up an incline and dumps it into the truck. No hand shoveling is required.

The conveyor extension that goes under the gondola car is flat enough to fit between the hopper and the rails. Speed of operation will be slightly increased if a tie is removed and a shallow pit dug beneath the rails, in which the unloader is permanently set. This eliminates the necessity of re-setting the unloader for each car.

The unloader will also handle material from storage piles.

Poison Gas Is Used to Eliminate Rats

NOW that the world is at peace, the United States Chemical Warfare Service has declared war against the pests that eat up the farmer's profits. Phosgene and mustard gas are proving as effective against rats as against an advancing enemy.

Rats and mice have been removed with remarkable success by flooding their underground tunnels and nests with phos-



Spraying a rat tunnel with gas

gene gas. The infested ground is covered by gas experts protected by masks, and carrying the gas in portable compressed cylinders. Whenever they locate the entrance to a rat tunnel, they insert the delivery tubes in the entrance and send in a blast of gas that reaches the rats even in the remotest crevices.

What Do You Want to Know?

Write the Information Editor
About Your Problems in Radio

The One-Wire Aerial

Is a single-wire aerial as good as a multi-wire aerial for radio receiving purposes? In speaking of a four-wire, 100-foot aerial, does the length refer to the length of each wire or to the combined length of all the wires?—W. S. U.

For receiving purposes, a one-wire aerial is just as good as a multi-wire aerial. Use a wire about 100 feet long and about 30 feet high. In speaking of a four-wire, 100-foot aerial, the length refers to length of each wire.

"Climate" and "Weather"

What is the difference in meaning between the terms "climate" and "weather"?—E. W.

In speaking of the "weather" we mean the condition of the atmosphere at some particular place and at some particular time. We refer to the temperature, the percentage of sunshine, or cloudiness, the wind velocity, and the precipitation of rain on a particular date. By climate we mean the average atmospheric conditions existing in a certain locality for a period of time, especially as they affect the animal and vegetable life of the region and the health and comfort of the inhabitants.

How to Adjust Your Set

Please give me full directions for tuning a vacuum tube set. —B. B. K.

Full directions for tuning a vacuum tube outfit are too lengthy to be given in this col-

umn or in a letter. The phases of radio are treated in detail in a chapter titled "How to Adjust Your Set" (pages 32 to 46) inclusive of POPULAR SCIENCE MONTHLY's new booklet, "The Standard Radio Set." By sending 50 cents you can obtain this book from our Book Department.

Alloy Melts at 212 Degrees

I want to make an alloy that will melt at the temperature of boiling water (212° F). What metals shall I use and in what proportions shall I use them?—W. J. S.

An alloy made of eight parts of bismuth, five parts of lead, and three parts of zinc will give you the desired result.

Indoor Aerial Is Safe

What kind of lightning protection is best for an indoor aerial?—J. F. D.

Lightning protection is unnecessary for any type of indoor aerial.

How to Keep Flowers Fresh

How can cut flowers be made to retain their freshness for a longer time than is ordinarily the case?—J. S. W.

Dissolve small quantities of ammonium chloride, potassium nitrate, sodium carbonate or camphor in the water in which the stems are inserted. The presence of one or more of the above chemicals stimulates the cells to action and opposes germ growth, thus keeping the flowers fresh for a longer time.

Receiving at 200 Miles

I am about 200 miles from KYW (Chicago). What kind of a radio set will I need to receive the concerts sent out by this station?—L. D. C.

Many amateurs get good results over such distances with single tube sets, or sets, but we believe that you should have no difficulty receiving the concerts if you use a vacuum tube set with two stages of amplification.

The Velocity of Light

What is the generally accepted figure for the velocity of light?—P. A.

The velocity of light has been published by the "American Ephemeris" at different times as 186,380 and as 186,330 miles a second. In recent years, however, after very elaborate determinations, 186,324 miles a second has been adopted.

EVERY reasonable specific query in the field of general science addressed to the Information Department will receive a prompt reply.

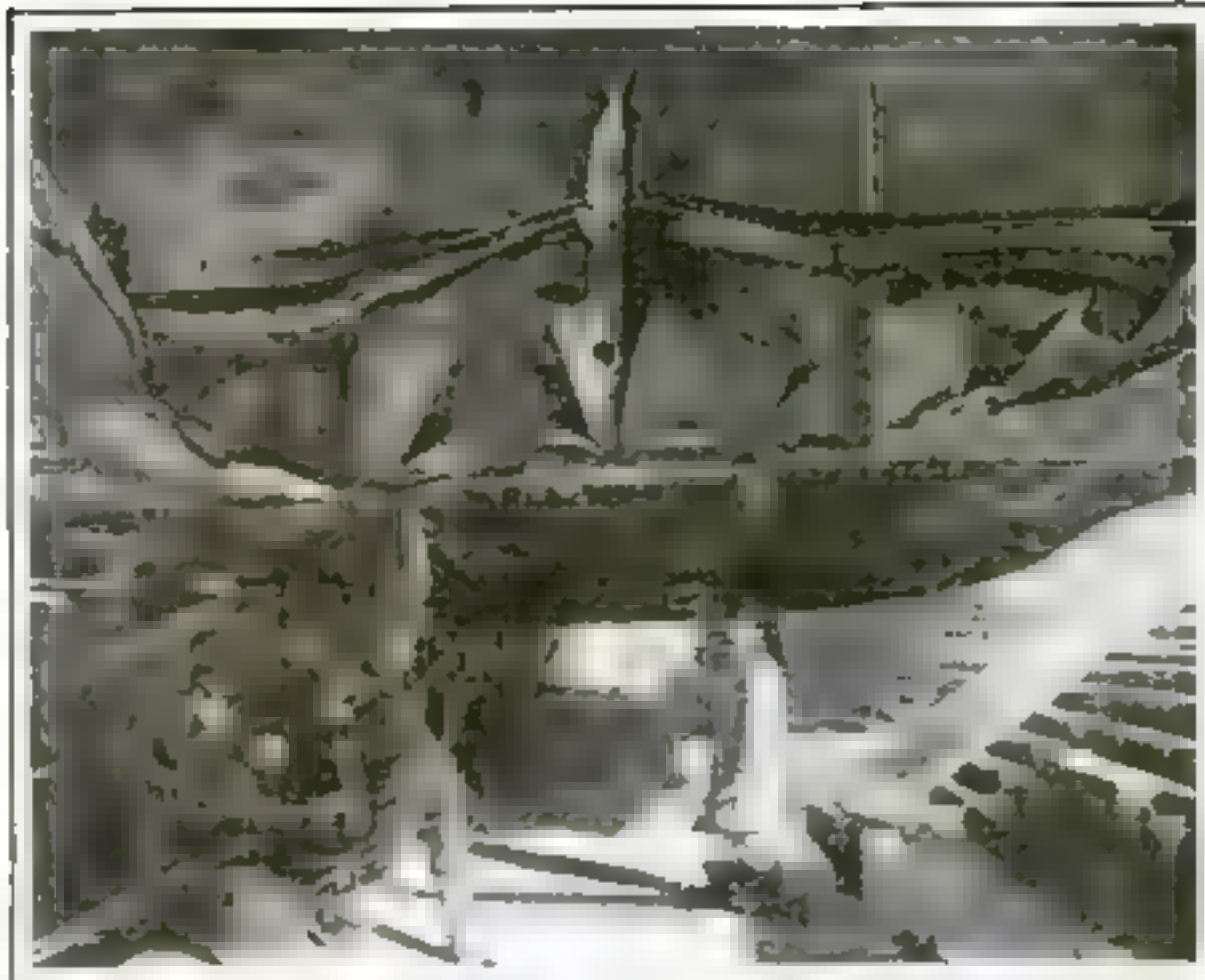
While lengthy replies cannot be given to complicated questions involving extensive research or computations, this department aims to be of maximum service in supplying information as to what books or other sources may contain answers to these questions. Legal and medical queries cannot be answered.

A stamped addressed envelope must accompany each question, but the writer's name will not be published if he so requests.

Address the Information Editor, Popular Science Monthly, 235 West 39th Street, New York City.

Bricks, Like Eggs, Now Travel in Cartons

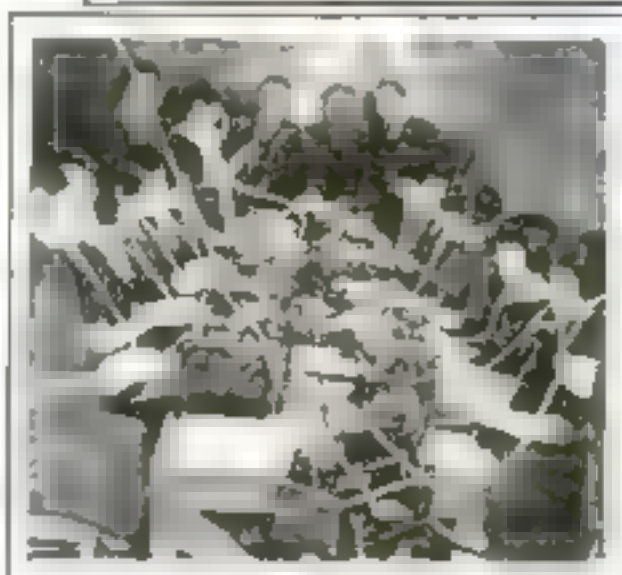
SHIPPING bricks in individual cardboard cartons, as if they were fragile as eggs, has been found profitable by a Los Angeles concern. Formerly, finely pressed and enameled bricks were often chipped and broken in transportation. The new protection eliminates breakage entirely.



"A Ship without a Bottom"

AN IDEA of what happens to the bottom of a ship when it is washed in a gale for a mile over reefs and through the surf is pictured above.

When the disabled tank steamer *F. D. Aache* was towed into New York harbor recently after a battle with a West Indian hurricane, in which she was wrecked on the Bahama reefs, shipping men characterized her as "the ship without a bottom." Nearly every section of her steel bottom resembled the crumpled sole of an old shoe. Just enough of the under-water structure was left to keep the vessel afloat by means of compressed air.



Ten Type from One Record

ONE dictaphone trains 10 typists at once in a modern business school. One machine is connected with a hollow tube running down the center of a table. The students plug their ear-tubes into small holes in the tube, and all 10 may take dictation simultaneously from one record.



© American News Service

Tire Tube for a Swing!

IT'S a long stretch, but the rubber still holds. The test stunt shown above is one method recently adopted by a rubber company in testing the flexibility of the inner tube of a bicycle tire. The tube, lifting wheel and rider from the ground, supports a total weight of 222 pounds.

Archer-Golfer "Drives" Arrow

A VARIATION of golf was demonstrated recently at Pasadena, Calif., where Samuel G. McMeen has startled orthodox golf players by appearing on the links with bow and arrow. McMeen challenges all comers. As his opponent drives his ball, the archer-golfer shoots his arrow. Each shot counts as a stroke. If the arrow lands on the green within six inches of the cup, it is considered in.



Money Used as Wallpaper

WITH Austrian crown notes worth only three hundredths of a cent, money was the cheapest material this German could buy to paper his room. European paper currency is so cheap that bills are even twisted into paper bags and sometimes used for pipe-lighters.

Violet Rays Detect the Invisible

IN THE heart of a genuine pearl lies a mysterious unseen quality that gives the gem its warm beauty and its value. What is it? How can this quality be detected so as to distinguish positively between the real pearl and the imitation?

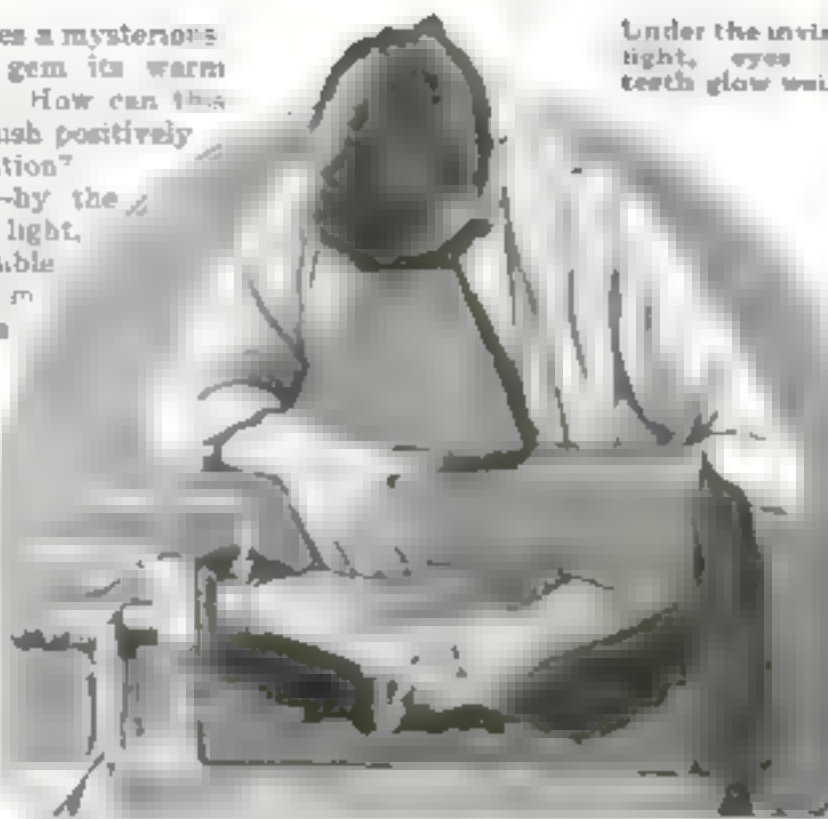
One way has been discovered—by the strange, invisible rays of ultra-violet light.

The unseen is detected by the invisible.

A pearl to be tested is held in the palm of the hand beneath the rays of a strong, bluish light. If it is a true gem, it seems to glow and burn as though it were painted with phosphorus; while if it is artificial, the pearl appears to be dull black.

To produce the peculiar effect, a light, rich in ultra-violet rays of long wave length, is required. Recently a small, compact mercury-vapor light has been perfected. The lens of this lamp is made of quartz, which does not absorb ultra-violet rays. If ordinary glass were used, all pearls would look alike under the light.

A patented color filter made of a nickel-oxide glass is mounted over the quartz lens. This glass absorbs almost all the visible light, while it permits the longer ultra-violet rays to pass. If you look into the light when this filter is in place, your eyes seem to be bathed with an invisible, balmy fluid. This sensation is the result of fluorescence of your eyeballs. Under the invisible light, your



Genuine pearls, tested under ultra-violet rays in this cabinet, glow like phosphorus. Artificial gems appear black.

eyes shine like a cat's, and your teeth and finger nails glow; yet a porcelain filling in your mouth will look black as coal!

It is this property—of causing fluorescence in some objects, but not in others—that gives ultra-violet rays their value in testing pearls.

Under the invisible light, eyes and teeth glow weirdly.



The testing cabinet is a box about three feet long, 16 inches high, and 16 inches broad. One end is open, except for a tight-fitting black curtain. The other end is pierced for the insertion of the lamp, lens, and color filter. In the top of the box is a small slot, fitted with a mask.

To test a suspected pearl, the jeweler thrusts his hand, holding the gem, through the curtain, and looks down into the miniature darkroom. If the pearl is genuine, it will fluoresce with a soft, bluish glow.

It is said that many manufactured gems, masquerading as the real thing, can be detected by this method.

Huge Searchlight Mirrors from Molecules of Copper and Silver

WHEN huge mirrors, five feet in diameter and perfectly formed, were needed recently as essential parts of army searchlights used in night signalling, scientists found a way to manufacture the mirrors in quantities without the employment of large numbers of skilled opticians.

One glass form—made by a process of carefully polished and ground glass—was used on which to duplicate metal mirrors of high quality.

First the chunk of glass over 60 inches in diameter and weighing 200 pounds is ground to dimensions. It is then polished until every particle of foreign matter is removed from the surface. A thin coating of mercury is applied to the glass in much the same way that simple mirrors are made.

The mercury covered glass is then placed in a frame and lowered into a silver-plating solution where the current is carefully con-

trolled. It is allowed to remain in this solution until the molecules of silver have piled one upon the other to a depth of several ten thousandths of an inch. It is then removed and thoroughly cleaned before immersion in another bath, this time of copper. The

copper is deposited on the silver until the entire metal plating is .03 inches in thickness.

After the plating solutions have completed their work the mirror is lifted to a table. A plastic material is carefully worked over the copper plating and later a

hard plastic

handling is done. The last process is to strip the final metal mirror from the glass form or mold and give it a very surface with a lacquer to protect it from atmospheric conditions, in a special room freed from all traces of floating dust.

The metal mirror has a surface and reflecting quality equal to the best glass mirrors made. It has an additional advantage in its ability to withstand hard usage with-



After passing through a silver-plating solution, the glass form is placed in a copper bath as shown above.



Above is the completed metal mirror, five feet in diameter, as used in an army searchlight.

Strengthened by plastic material and a steel cap, the mirror is stripped from its glass form.

The Fastest Things of Their Kind in America!

TWO hundred miles an hour—more than three miles a minute—nearly 900 feet a second! Measure that 300 feet with your eyes, then watch the little hand tick off one second, and you will have some idea of the fastest man-made thing in America. It is the triplane known as the *Cactus Kitten*, with which Clarence Coombs took second prize at the Omaha air meet and in which he intends to try for the official world's speed record this summer.

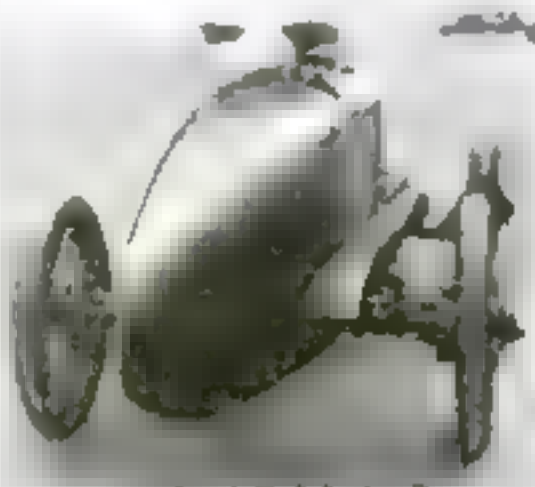
To visualize the fastest man-made thing that travels on and not above the earth, imagine yourself whizzing over the hard sand at Daytona Beach, Florida, at the rate of three miles a minute. That's the unofficial record set a few weeks ago by Sig Haugdahl in his Wisconsin Special racing car. He covered a mile in 19.97 seconds, or at the rate of 180.27 miles an hour. The official world's record is 169 miles an hour.

The significant thing about these seemingly impossible feats is the fact that in each case careful streamlining and light-

Where they would be at
the end of an hour



Crossing the starting point abreast, and maintaining top speed for an hour, the record holding racers shown above would finish at the milestones indicated. When will a man-made machine overtake the alderdown duck?



Only 20 inches wide at the body's widest point! Above is a rear view of Sig Haugdahl's air cutter at Daytona Beach, Florida. Note the long knifelike tail.

weight, they ride almost flat. They are supported on streamlined slab struts. The motor, turning at 2250 revolutions a minute, weighs only 700 pounds for 425 horsepower, or 1.61 pound to the horsepower.

Similar streamlining principles are carried out in Haugdahl's auto. The body of his car at the widest point is only 20 inches wide. The wind displacement is said to be less than one third that of any other machine driven in world's record speed trials.

This knifelike speedster is driven by a six-cylinder motor that develops 250 horsepower, yet weighs only 600 pounds.

With pointed, whirling nose and streamlined fuselage, the *Cactus Kitten*'s total area of resistance is only 8 1/2 square feet.



Driven by a 250-horsepower hydroplane motor, the fastest car in America traveled three miles a minute.

weight, high-powered engines appear to have been responsible for them.

Consider the *Kitten*, a triplane eight feet high and 23 1/2 inches long, with 20 foot wing spread. The total area of resistance of its streamlined fuselage is only 8 1/2 square feet! Even the radiator consists of streamlined piping carried behind the wings. The wings have practically no angle of incidence—that is, when the plane is traveling hori-

Medal-Making Machine Reproduces Finest Work of Artists

A MACHINE that automatically reproduces an artist's bas-relief design in any scale without alteration of the slightest detail is responsible for the artistic perfection of the latest coins and medals. Guided by soft wax forms, drills now eat their way into solid blocks of steel, turning out dies that are exact copies of the sculptor's work—a thing that was virtually impossible with hand die-cutting.

The artist's model, sculptured in wax or



Blank medals are stamped from steel dies in this 500-ton press.

plaster, is fastened to a horizontal shaft on the cutting machine and a die blank of the softest steel is placed on a parallel shaft. Both revolve together at exactly the same speed. Between the model and the die runs a steel pantograph arm, carrying at one end a pointer resting against the model. At the other end is a small drill with a sharp point shaped like a four sided pyramid, resting against the die.

Drill Cuts Replica in Steel

As the pointer follows the curves and details of the model, the weight of the steel arm forces the drill point into the steel, where it cuts out a reduced replica of the wax plaque. The steel die is then hardened and tempered, and placed beneath a 500-ton stamping press.

The blank medal, punched from a sheet of bronze or silver, is placed between two dies and surrounded by an iron collar. The knuckle in the punch arm makes the dies first strike the medal and then press upon it. From three to twelve blows are necessary to reproduce all the details of the design. As this pressure hardens the surface of the metal, the blank must be annealed between stampings to soften its surface.



With a pantograph arm, details of the wax model are drilled into a steel die.

Inner Tubes Prevent Water Pipe Bursts

IT IS a fact not always recognized that, when water-pipes burst, the damage is actually done at the time the water within them is frozen. We only become aware of the burst when a thaw sets in and the pipe begins to leak.

Beyond emptying all exposed pipes during, or in anticipation of, a hard frost, no satisfactory expedient has yet been devised for preventing these unfortunate accidents until this simple scientific device illustrated was patented.

When water changes to ice, its expansion exerts a pressure of fourteen tons to the square inch, but if an internal air space were provided throughout the length of an exposed pipe, it is clear that instead of bursting the pipe, expansion would take place internally by compressing the air in such a space. The inventor's idea is simply



Internal expansion space in the pipe is provided by a rubber air tube

to insert a small watertight rubber air tube to provide such an expansion space.

The method has been tested, with the following results: Four short sections of ordinary three-quarter-inch steel pipe were filled with water and sealed by means of stout pipe caps screwed on over the ends, small rubber tubes one eighth inch in diameter being inserted in two of them beforehand. All four were then subjected to 14 degrees of frost until the water had frozen to a solid core of ice. Upon examination it was found that, whereas the two pipes containing the air tubes were intact, the other two had burst for almost their full length—a fair proof of the efficacy of the inner tubes.

BRITISH weavers have produced an artificial fabric said to be warm as wool, with the appearance of silk. Fibers discarded in making artificial silk are spun into the product.

Sixty-Five-Ton Rotor Rolled Ten Miles in Ten Days

ROLLING a 65-ton dynamo rotor ten miles over the road to a power house proved to be easier than delivering it on a special truck. The grades over which the machine had to be hauled were as high as 10 per cent. It was found that two tractors could roll the rotor, while seven motor-trucks, in addition to two tractors,

IN ENGLAND, motor-trucks with special box-stall bodies are now being used to transport race horses from one track to another. It has been found that travel on railroad trains is extremely hard on the physical and nervous condition of a thoroughbred.



When the horses are inside this box-stall truck the spring runways are raised to form the back and sides.

Conditions met in a journey over a highway are less nerve-racking, and even after a long all-night "jump" the horses are in better condition for a race when they are carried by truck. Each carries two horses, which enter the stalls by the rear ramps and go out through the side doors.

Mirror for Invalids Permits Shaving in Bed



The mirror clamps on the patient's knees

INVALIDS can now shave comfortably in bed, thanks to a new mirror that clamps on the patient's knees and that may be easily adjusted.

The mirror, an invention of Harry J. King, of Oaklandon, Ind., is supported by two L-shaped members working on a hinge at their junction, and padded at the lower end so that they may be clamped either to the bed or to the knees. The glass is attached by a universal joint to a rod sliding through the central hinge, and can be raised, lowered, or turned to either side, and held in the desired position by tightening the wingnuts.

The Banjo No Longer Speaks in Muffled Tones

THE volume of tone from a banjo can be doubled, it is claimed, by a new sounding-board that collects the vibrations of the under side of the head and delivers them through a horn straight at the audience.

In most banjos only part of the possible tone volume is heard, as the instrument



Horns double the sound of banjo

must be held close against the body of the player. In this way the vibrations of the under side of the head are usually muffled and lost. But in the new instrument this is prevented by a wooden back and a horn.



© Engineering News-Record

Seven trucks and two tractors were required to haul this rotor over grades



Two tractors rolled a similar rotor by unwinding cables from the drum

As a special service to readers, the Editor will be glad to supply the names and addresses of manufacturers of devices mentioned in Popular Science Monthly.

Iceberg Detector May Prevent Disasters at Sea

WHEN great icebergs, breaking away from the winter pack off Newfoundland, drift southward across the transatlantic steamship lanes, the sea captain is confronted with one of the most deadly perils of the sea. As his ship plunges through darkness and must at 20 miles an hour, he anxiously peers into the gloom ahead, watching for the frosty gleam that may warn him, perhaps too late, of disaster.

In the future, danger of such disaster may be eliminated by the use of a small parabolic mirror, recently invented, that detects icebergs six miles away by collecting radiations of infra-red rays. And, since fog is no barrier to those rays, the new device may greatly reduce collisions.

The parabolic gilded mirror, which is the chief part of the new instrument invented by M. A. Lurigaldie, engineer and electrician of Paris, France, moves freely around a vertical



When the parabolic mirror points at an iceberg, infra-red radiations lessen the current in the thermo-electric element. This difference in current is detected in telephone receivers on the captain's ears.

axis, while at its focus is a sensitive thermo-electric element.

While infra-red rays, like the ultra-violet rays at the other end of the spectrum, are invisible, they affect the resistance of the thermal element. Radiations from melting icebergs are especially rich in infra-red rays. When the mirror points at a berg, the radiations will cause a marked change in the current flowing through the element. The difference is detected by telephone receivers on the captain's ears, and thus he may change his course in ample time to avoid a collision.

It may soon be possible to utilize this instrument at night by sending out a powerful beam of ultra-red rays in the path of a ship, using a signaling tube developed during the war. The beam will be reflected from any ship or berg in the vessel's path, and the mirror will catch the warning.

Gasoline-Electric Auto Simplifies Driving

DIFFERENTIALS, propeller shafts, friction clutches, speed gears, and other trouble makers have been eliminated in a gasoline-electric motor car, recently developed. The motive plant of the automobile consists of a two-cylinder gasoline engine, the crankshaft of which is parallel to the front wheel axle. At each end of the shaft is a circular field magnet that also serves as a flywheel. The armature of each field magnet is in the form of a disk so mounted that it can rotate in a plane parallel to that of its magnet. The two armatures transmit their motion to the driving gear of the front wheels by means of a sprocket chain.

When the gasoline motor is started, the field magnets are set in rotation and the

magnetic force, acting upon the armature disks, causes them to rotate in the same direction, but with lesser speed. This difference between the speed of the magnets and that of their armatures introduces an element of elastic adjustment into the working of this type of propulsion.

If the car, for example, travels uphill and, consequently greater power is required, the increasing drag on the armatures will cause them to rotate more slowly. But the increase in the difference of speed between magnets and armatures will automatically produce the generation of a stronger electric current. This is utilized for accelerating the gasoline engine and increasing the driving power of the armatures. The car runs with unusual smoothness.

Movie Camera Films Furnace Fire



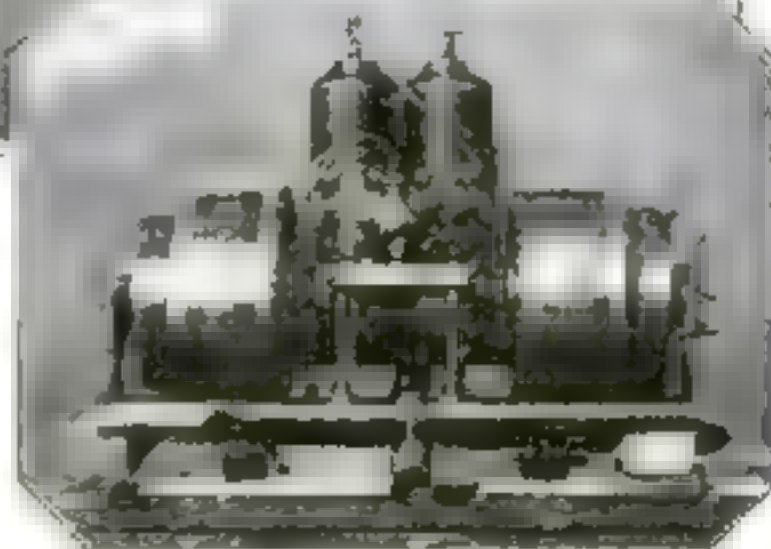
A photograph of the blazing furnace fire and the apparatus that took it.

MOVING pictures of a furnace fire photographed through a metal screen by Mr. Sanford Riley, of Worcester, Mass., have supplied new facts of what actually happens in mechanical stoking. As a result, a mechanical stoker of twice the customary size, having a coal bed 20 feet instead of 10 feet long, may soon be commercially practicable.

Intense heat was the greatest difficulty to overcome, for it cracked the camera lens repeatedly until protection was given by a device that might seem to make photography impossible. In front of the lens were placed two sheets of heat-resisting glass, with a single thickness of gold leaf between them. Gold leaf is opaque to the eye, but here it acted as a mirror that threw 75 per cent of the radiant heat back into the furnace and allowed about 75 per cent of the light from the blazing coals to pass through to the lens. This proved to be sufficient light for effective photography.

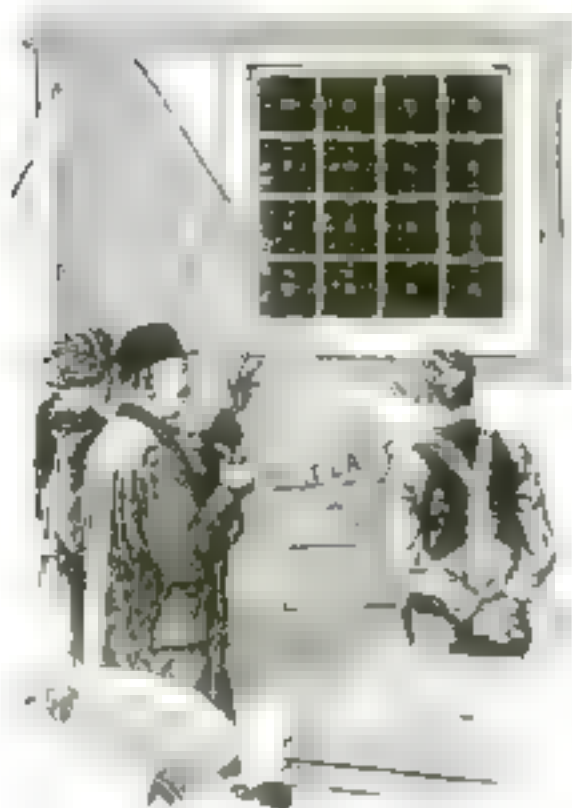


In the installation of the gasoline-electric engine, as pictured above, the crankshaft is parallel to the front axle. Circular field magnets at each end of the shaft serve as flywheels. Armatures revolved by the magnets transmit their motion to the front-wheel driving gear by a sprocket chain. At the right is a close-up of the engine and dynamo.



A Problem in Profitable Horse Trading

Best Solution to This and Other Puzzles on This Page Will Win \$25 in Prizes



Count the Rectangles

WHEN the glaziers had completed the window in the professor's new bungalow, that satute gentleman contemplated the work, then spoke as follows.

"In viewing your admirable artistry I perceive that within the large square formed by the boundary of the window there are 16 small squares, and that the dividing lines of the panes form an interesting variety of rectangles. Now, remembering that a square is always a rectangle, but that a rectangle is not always a square, how many different rectangles can be counted in this 16-pane window?"

Let us figure it out for the professor.

What Did the Squire Get for His Horses?

SQUIRE PERKINS says he has found it pays to figure horse deals in double transactions; that is, two horses, whether bought separately or together, always figure in his calculations.

For example: The other day the Squire sold a pair of horses at auction, and when the auctioneer handed him a check for \$493 68, the old horse trader remarked "Not so bad, for while I have lost 10 per cent on one animal, I make 12 per cent on



the other, thus clearing two per cent on the whole transaction." What did he receive for the horses separately?



How Many Bricks in Hod?

THE other day when a friend of mine encountered a man about to go aloft with a hod of bricks, he detained him long enough to gather some brick facts.

When the workman was asked as to the weight of a brick, he replied:

"A brick weighs three quarters of a brick and three quarters of a pound."

"Just so," assented my friend, "and can you tell me how many bricks there are to the hod?"

Then the fellow imparted some curious information, as follows:

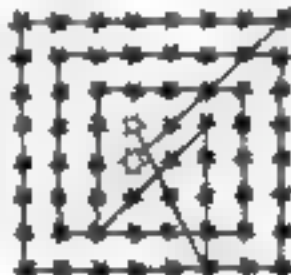
"Half a hod and half a brick weigh 14 pounds less than three quarters of a hod plus three quarters of a brick."

Taking as a basis the workman's strange figures for the weight of a single brick, how many bricks does the hod hold?

June Puzzle Solutions

THE COMET'S COURSE

The diagram illustrates the course of Donati's comet in 14 straight lines which clear the field, and end with the large white star.



THE RAILWAY JUNCTIONS



THE diagram illustrates the method of laying the six tracks across the circle to produce 16 junctions, showing the limit of possibilities.

SETTLING A STRIKE

THE foreman received \$1 10 the first day, then worked 90 days at \$1.11, making 91 days for \$101. Handy man worked 101 days for \$101. Helper worked one day at 90 cents, then 110 days at 91 cents, making 111 days for \$101.

A FIRST prize of \$10 will be awarded for the best set of answers and analyses covering the three problems on this page; a second prize of \$5 for the next best set; and 10 prizes of \$1 each for the 10 next best sets.

Answers must be received not later than July 1, addressed to the Puzzle Editor, Popular Science Monthly, 225 West 39th St., New York, N. Y.

Answers to the puzzles on this page will appear in the August issue; the names of prize-winners in October.

April Prize-Winners

PRIZE WINNERS in the April contest are as follows:

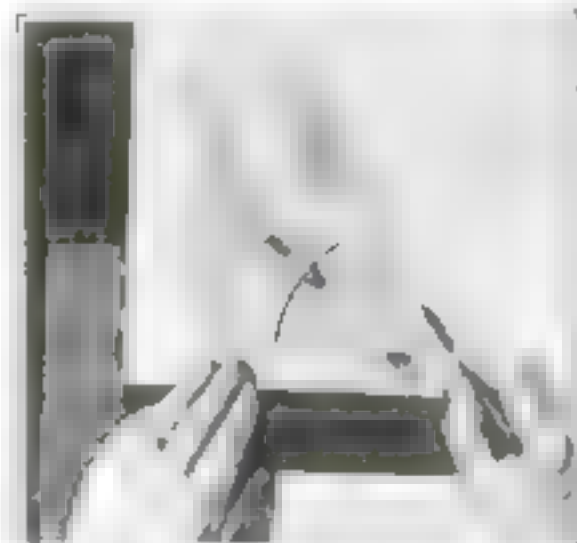
FIRST PRIZE, Ten Dollars: H. D. Clayton, Hill City, Kans.

SECOND PRIZE, Five Dollars: Max Silverman, Ada, Ohio.

The TEN One-Dollar Prizes: John Chuncharick, Canon City, Colo.; T. P. Lyon, Fairhope, Ala.; Addie R. Vauxburgh, Berkeley, Calif.; John Hier, Syracuse, N. Y.; W. D. Booker, Wawanesa, Man., Canada; H. E. Birkinshaw, Elm Springs, Ark.; Abies Quillian, Greenville, Ala.; Rubin Atkin, N. Y. C.; Geo. H. Muller, Atlantic City, N. J.; J. F. Fonville, Jackson, Miss.

Adjustable Set-Square Aids in Drawing Angles

FOR the mechanical draftsman a universal adjustable set-square with which it is possible to draw lines at an angle much faster than when using a protractor, has recently been invented. The instrument is a celluloid 45-degree triangle, one face of which is in the form of a hinged blade equipped with a scale by which it can be set at any angle. The scale is a white celluloid arc with a transparent cursor



With the angle set, the instrument is moved in contact with a T-square



Canteen Distills Breath

A canteen that never goes dry has just been invented by Dr. Alexander Graham Bell, father of the telephone. Even in the desert or at sea the container will assure a constant supply of drinking water, it is said, for it distills moisture from human breath.

The canteen consists of a glass tube and bottle. The wearer expels breath into the tube. Much of the moisture in the breath is condensed—as much as an ounce an hour, or more than enough to sustain life, says Doctor Bell. The water thus distilled is pure.

Crane Lifts and Dumps Cars

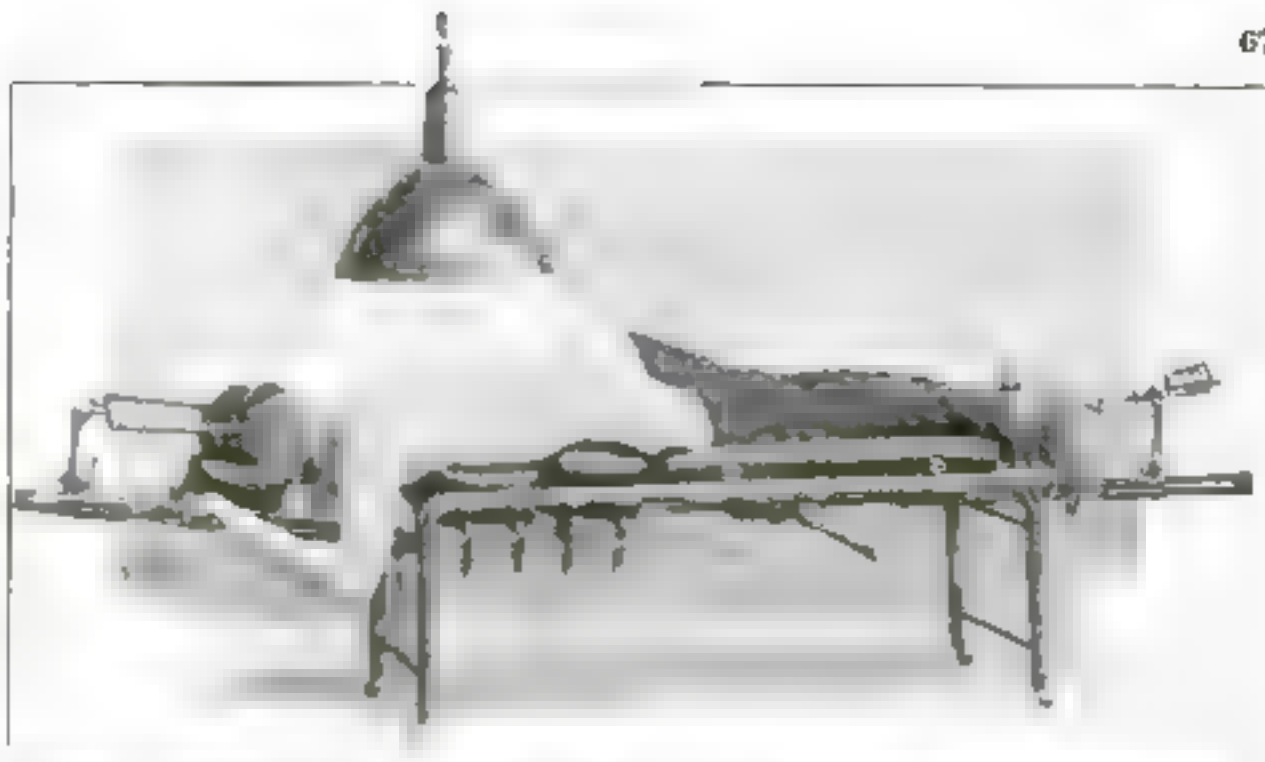
A crane that lifts a loaded coal car bodily from the tracks, weighs and dumps the coal, then returns the empty to the rails, has recently been built for use in industrial plants.

Two steel tackles ending in double chains that are attached to the car just below the axles handle the car as shown in the photograph at the right.



Concrete Relayed

By the use of a novel relay tower, the contractor for the North Avenue Bridge at Milwaukee, Wis., recently was enabled to place 17,000 cubic yards of concrete from one central mixing station. The mixture was started from the tower seen at the left in the photograph below, then hoisted to the top of the tower on the right, and distributed from that point through a swiveling spout.



Nerves Treated on the Rack

Stretching the backbone to relieve twitching nerves and muscles while the patient is exposed to the curative effects of heat and light rays is a new method of treatment for nervous disorders developed by Dr. Jacob Reemer, of Waukegan, Ill.

The apparatus, shown above, consists of a cushioned table upon which the patient lies comfortably while straps are fastened about his head and feet. These straps are attached to rigid brackets sliding on a rod extending beneath the table. Stretching is accomplished by turning a crank that moves the brackets.

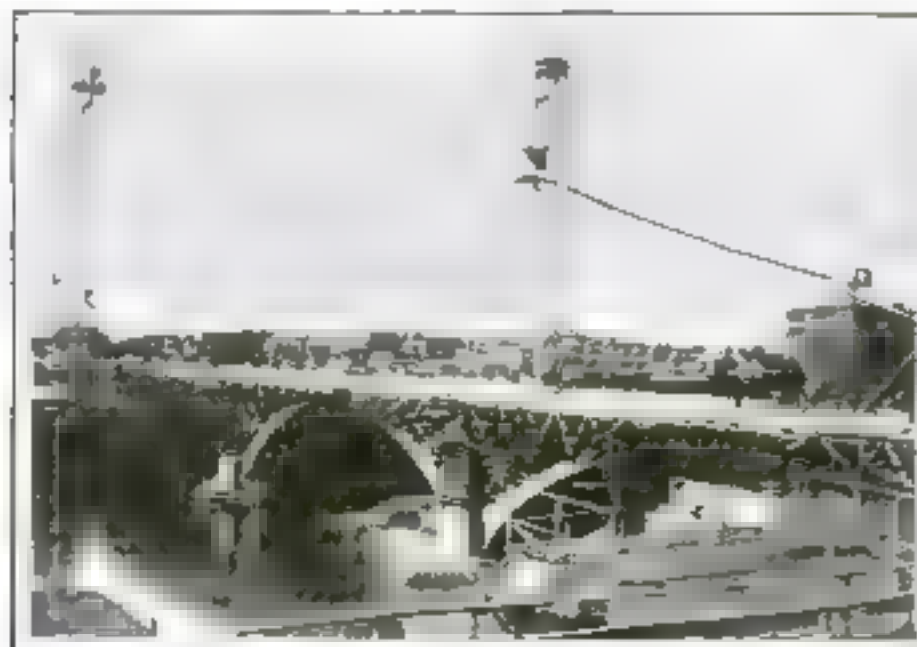
The stretching is administered without jerks. If the crank were turned rapidly and too far, the apparatus would become a "rack," like the dreaded instrument of torture used during the Middle Ages.

"Walker" Mends Dog's Back

Even a broken back doesn't prevent "Sandy," a full grown Airedale, from taking his daily stroll. When the dog was run down by an automobile in Philadelphia recently, the walker shown in the illustration was used to aid in his recovery. With his back in splints, "Sandy" is lashed to a framework set on rollers. This supports him as he walks.

Linoleum on Street

Strips of linoleum were laid recently on a busy street corner in Los Angeles to test the durability of the material. When the linoleum, shown below, was removed at the end of the day, it had not been appreciably damaged, although more than 15,000 vehicles had passed across it. This is said to be the equivalent of several years of wear.



Indoor Calculator Measures Power of You



When in contact the two ends drop, and this happens, equal for the other, it is a sign of a good fit. If the cylinder is over size the space between the pins will show the excess.



Compare the results of the test with the results of the test of the other, it is a sign of a good fit. If the cylinder is over size the space between the pins will show the excess.



This is a test for garage or house use. It is a test for the fit of a cylinder. It is a test for the fit of a cylinder. It is a test for the fit of a cylinder.

It is a test for the fit of a cylinder. It is a test for the fit of a cylinder. It is a test for the fit of a cylinder.



It is a test for the fit of a cylinder. It is a test for the fit of a cylinder. It is a test for the fit of a cylinder.



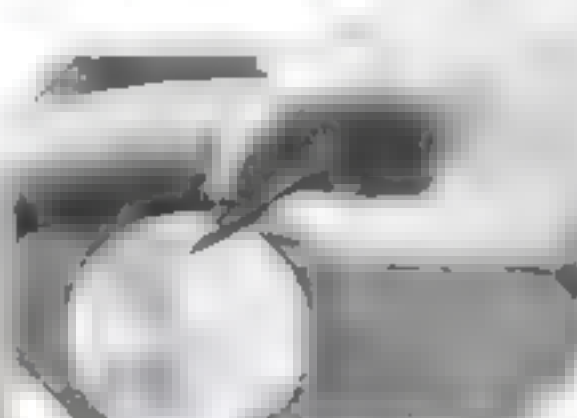
It is a test for the fit of a cylinder. It is a test for the fit of a cylinder. It is a test for the fit of a cylinder.



Stickers on the door will show the results of the test. It is a test for the fit of a cylinder. It is a test for the fit of a cylinder.



To prevent theft of your car, the door can be locked. It is a test for the fit of a cylinder. It is a test for the fit of a cylinder.



It is a test for the fit of a cylinder. It is a test for the fit of a cylinder. It is a test for the fit of a cylinder.



Any number of chains may be placed on a truck wheel equipped with an iron ring fastened to the spokes and to which the chains are attached by stud links.

As a special service to readers, the Editor will be glad to supply the names and addresses of manufacturers of devices mentioned in POPULAR SCIENCE MONTHLY.



This continuous tread of steel plates can be fastened around the drive wheels of a truck without injuring rubber tires.

Midget Washing Machine Saves Space in Home



A cooking stove that may be pushed out of the table with this electric stove with three heat control and utensils for broiling, boiling, toasting, and frying



To prevent slipping of rug laid on polished floors, this rubberlike fabric, coated with rubber composition is fastened to the under side



A gentle current of the air from the fan in the lid prevents juice from running over into the oven while a pie is being baked



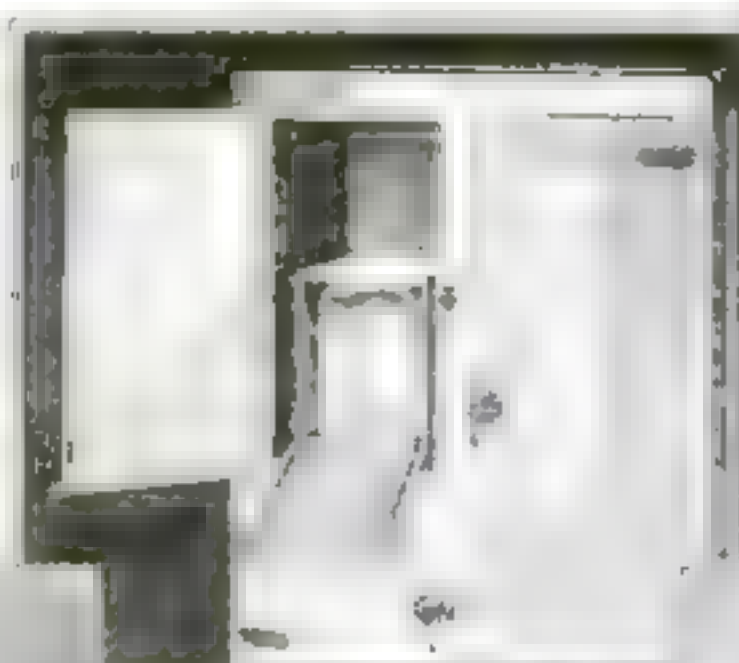
In this compact portable washing machine, the container (at left) is fastened to the plate (at right), which is tilted back and forth and around by an electric motor



A saucepan that won't let over Water seeping through holes in the cover, which is locked well below the rim, runs back into the pan



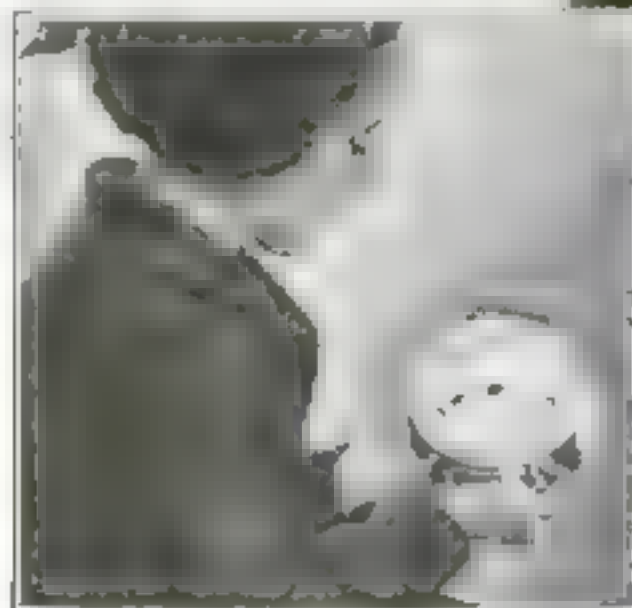
The bulge near the top of this coffee pot increases the diameter and cools the liquid before it can boil over



With double walls between which cold air circulates, this container prevents wasteful melting of ice and keeps the refrigerator clean



Contents of this sanitary food container are hermetically sealed by a tight cover with rubber gasket, that is held by an aluminum clamp



The alarm of this eight-day clock can be set 24 hours in advance. A signal (indicated by arrow) tells when the alarm will ring

AS a special service to readers, the Editor will be glad to supply the names and addresses of manufacturers of the new devices mentioned in **POPULAR SCIENCE MONTHLY**.



The bacon frizzles while the water boils. This breakfast kettle is fitted with tubes through which heat passes to the frying pan above

My Ideal Radio Receiving Set

How an Amateur, Advancing by Easy Stages from the Simplest Equipment, Planned the One Best Outfit to Meet His Needs

By Armstrong Perry

IDEALS differ. Some men select blondes and others are carried away by brunettes.

Also, ideals change. The blonde may become first the wife and then the complainant, and the brunette may become the co-respondent.

Just so, men are bound to change their minds in radio, advancing from one conception of the ideal radio set to another, as the limitless possibilities of recreation, entertainment, instruction, research, and financial profit through universal communication spread new vistas before them.

The Beginner's Ideal

Until quite recently the beginner's ideal was to have a receiver—any kind at all that would enable him to hear even one station. This usually meant a crystal detector, a loose coupler, a pair of phones and some wire. As I look back upon my own early experiences, I still feel that this as a first outfit is ideal for the man who lives in a town with a broadcasting station. Every one knows how much better it is to begin with a fiver than to climb trees with a limousine.

My second ideal radio set was one that would tune more accurately than the first and thereby shut out the interference that sometimes prevented hearing the message I was fishing for with crude apparatus. Then I wanted one that was more sensitive, so that it would bring in messages from a greater distance. That meant vacuum tubes, grid leaks, condensers, verniers, and a lot of apparatus that a beginner might be able to use when it was properly adjusted, but that would confuse him hopelessly when things went wrong.

After using such a highly developed receiver long enough to master it, in the solitude and silence that are necessary when a man is taking his first steps in radio and

needs to concentrate on every sound, he begins to realize that his hobby is a selfish one unless he shares it with the family. That requires the use of an amplifier and a loudspeaker, which will provide entertainment for a roomful of people.

In removing the home receiving station from the den or other out-of-the-way corner in which it saw its early development, certain adaptations must be made. Leakage of sulphuric acid solution from a storage battery is not serious on the rough board floor of the attic, but on a velvet carpet—! In the little old booby hatch the outfit could be locked up to keep the kids away from it, but in the music-room even the smallest member of the family will want to show it off. The way of safety is to make

the controls simple and give everybody instructions in the operation of the set.

No sooner is the outfit installed permanently in the most favorable location than some one suggests radio music with meals. That requires an antenna connection in the dining-room, and, while we are about it, in various other rooms where the receiver might serve a useful purpose. The station becomes portable.

A Portable Outfit

Then, with the radio habit firmly fixed, there comes the summer vacation. Having enjoyed the privilege of listening in on the world while in town, we certainly do not want to miss it when we are out in the wilderness. Space in the car is limited. We cannot carry a radio receiver as large as a phonograph. Another ideal is formed—a receiver that will be as efficient as the big one and as small as the little affair with which we started.

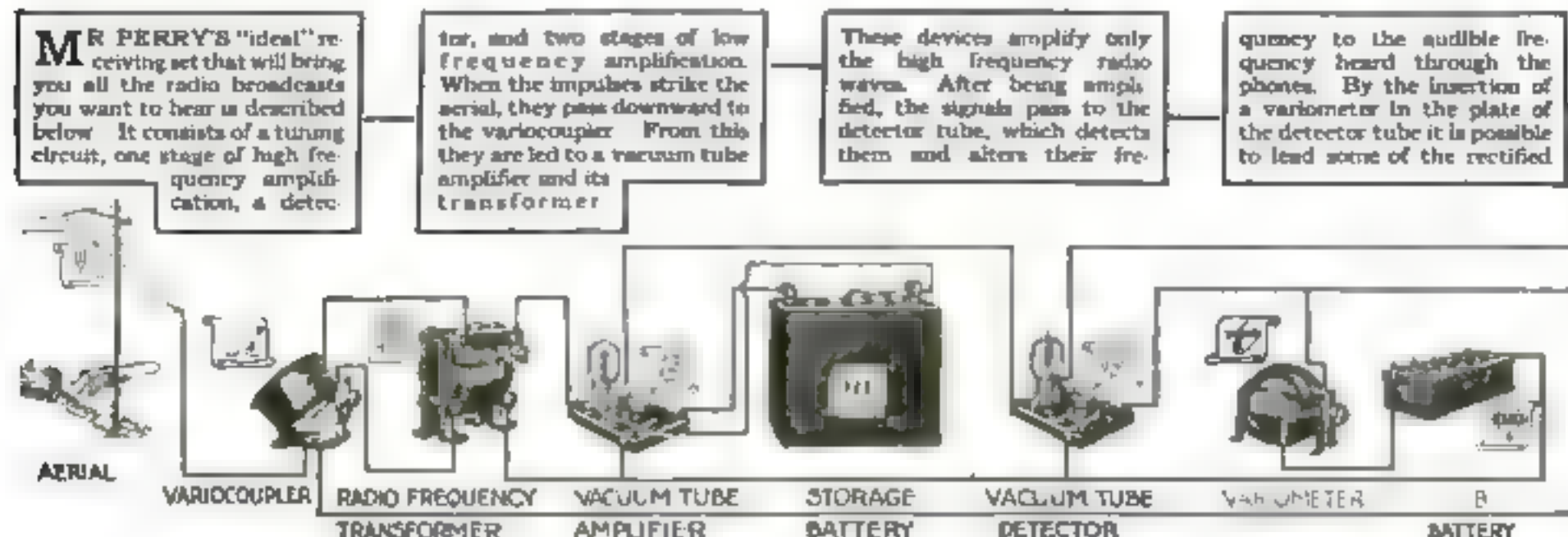
All of these ideals are attainable by easy stages and at expense smaller than the tobacco bill of the average smoker. Some men will skip some of the stages of development. The cowboy on the plains, for example, has to begin with a highly efficient outfit, for a crystal detector will bring nothing to his isolated cabin but the bill, unless he be a genius. But any one, anywhere in the United States, can get what he wants by radio if his ideals are within reason and his persistence reasonably strong; a condition possible in no other country at present.

The ideal complete outfit for a beginner consists of an antenna to pick up energy from the radio waves; a lead-in wire to carry the energy to the receiver; a protective device to keep lightning from going in along the same path as the radio currents; a detector to change the radio currents to pulsations that will make sounds in the phones; a tuner to select the station he



The Right Way

This represents the kind of receiving set Armstrong Perry recommends as having all the advantages you will ultimately want. Note the tuner, capable of tuning in all waves between 200 and 25,000 meters; the radio frequency amplifier at the extreme left, and the two stages of audio frequency with loudspeaker at the right.



DON'T throw away money on your radio set. Don't buy parts only to scrap them later. Don't build up a receiving outfit that looks like a junk shop when completed.

You want the best set you can get, at the least expense. You want it to be an attractive addition to the home, instead of an eyesore. Therefore, you want to know where you are going before you start. You want a plan.

Armstrong Perry, in this unique article, attempts to picture for you an ideal receiving set in its first, intermediate, and final forms. He shows how to plan your finished set intelligently from the beginning, getting the maximum service out of your apparatus at each stage, always working toward the really complete radio receiver that will bring you everything going in the way of radio broadcasts.

wants to hear; a single phone or double head set; and a wire connecting with the earth.

The antenna must be a good one. For receiving only, a single wire has always given me just about as good results as more elaborate aerials. The wire should be at least 30 feet above the ground, and if it must be strung above a metal roof it should be as far above that as possible.

Lightning Protection

Porcelain or composition insulators serve as dams and sluiceways to turn all the current into the receiver through the lead-in wire. A lightning switch or an arrester performs the function of a floodgate or spillway to carry off any excess of current put into the wire by a heavy electrical discharge. Without these protective devices an insurance policy does not insure against loss from lightning. The antenna wire is bare, but the lead in is heavily insulated from the lightning switch to the receiver. It enters the house through a porcelain tube.

The outside wires are large, about No. 14, and if they are made of seven or more strands they will bring in more energy than solid wires. The end of the antenna to which the lead-in wire is attached points toward the stations that will be heard most loudly, other things being equal. Or, if the lead-in wire is soldered to the exact middle of the antenna wire, stations pointed at by either end of the antenna will be heard equally well.

For the beginner's set in the town where strong stations transmit the daily broadcasts, the galena detector is the standard. A man in Texas says he hears a German

station just outside of Berlin, and scores of distant American stations, with a galena detector. My receiving range is shorter, but I hear concerts every day, church services on Sunday, and lectures and addresses often. Sometimes I listen in on airplanes in flight as they exchange messages with air stations on the ground. After making two adjustments I can go out for the evening and leave word for the other folks in the house to help themselves when the broadcasting program starts. Frequently I return to find that they have enjoyed a good evening's amusement while the fellow with the "good" station that I have been visiting has been telling me how clearly he heard KDKA week before last and what a corking show he could have given me "if the static

phone that sells at about 55 cents wholesale and it brought in signals from one near-by station as loudly as the better phones for which I paid \$12.

For my ground wire I use a piece cut from the same coil as the antenna. Unlike the antenna, the ground wire need not be kept from contacts. The faster it leaks the current, the better it fulfills its purpose.

In graduating from a crystal detector set to a vacuum tube receiver I began with an outfit using one tube only. Amplifiers come in separate cabinets that can be easily attached to the single-tube outfits, so there seems no more reason for starting with three tubes than there is for trying to juggle three baseballs before learning to catch one.



The Wrong Way

Here's what your radio receiving station may look like if you don't visualize your final outfit from the very start. This station is, doubtless, highly efficient—but it is no ornament to the household. Compare its appearance with the attractive and compact receiving station that is illustrated on page 70.

had not been so bad," and so on.

Without a tuner of some sort no receiver is ideal, even for a beginner, unless he is interested in hearing only a very limited number of near-by stations. Tuners are divided into two general classes: short-wave and long-wave sets. Short-wave apparatus brings in messages from amateur stations and from the principal broadcasting stations. Their tuning range is from 160 meters or less, up to perhaps 600 meters.

Phones Influence Sound

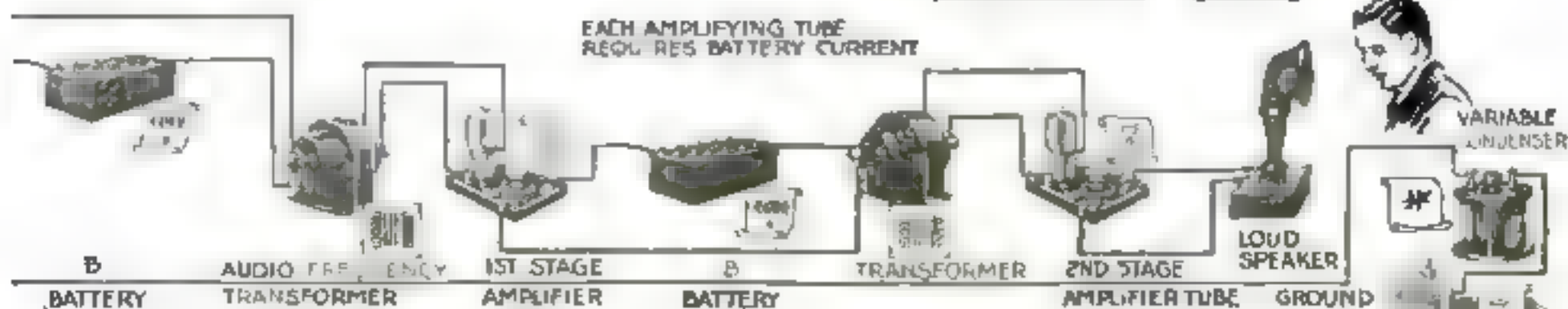
I have found the greatest simplicity and the highest efficiency in what is known as a single-circuit receiver using a variometer as the tuner. The type phones used makes a great difference in the loudness of the music, voices, or signals as received. The best I have used are of a well-known type having mica diaphragms. On the other hand, I have experimented with a

current back to the grid to further strengthen the incoming waves. From the detector tube the strengthened signals are passed through an audio frequency transformer and a

third tube, which again amplifies the signal. The impulses from this tube are passed through another amplifying transformer and through the second audio fre-

quency tube. The signals are now many hundreds of times stronger than when received on the aerial loud enough in most instances to operate loudspeaking instruments. In the sketch below some of the stor-

age batteries used to light the filaments of the vacuum tubes are omitted for the sake of clearness. Each tube must have current from a storage battery and also from a dry B battery.

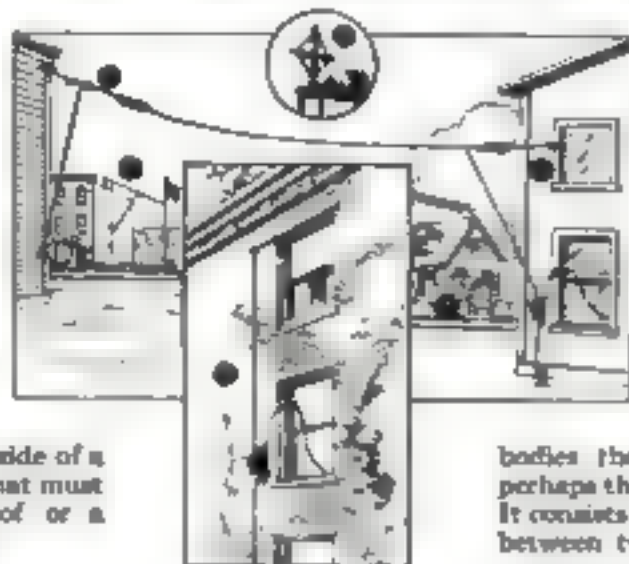


The Five Best Ways to Erect an Aerial for Your Ideal Set

EVERY radio receiving set requires some type of antenna. While facilities are not always available to permit the erection of the very best type, still, there is always a one best method of antenna construction for receiving under any given set of conditions.

The accompanying diagram, showing five different types of aerial, will help you in planning your own ideal set. The methods, as numbered, are:

1. This aerial consists of a single vertical wire suspended along the side of a house. It is a type that must be used where a roof or a yard is not available.



2. The "indoor loop" can be used for experimental work or where the receiving set is located close to a broadcasting station. For medium distance reception a loop aerial must be used in conjunction with two or more stages of amplification.

Since a loop aerial receives best from directions in the vertical plane of its coil of wire, it is frequently used in preference to better aerials when it is desired to eliminate annoying interference.

3. The construction here embodies the most common and perhaps the most successful type. It consists of a single wire strung between two supports with the

lead-in wire taken from the end nearest the receiving set. This aerial is directive—that is, it will receive best from stations in the direction of the lead-in wire.

4. This antenna is similar to No. 3, except that the lead in is taken off at the midpoint of the aerial wire span. This aerial has a shorter wave length, but possesses the advantage of receiving equally well from all stations in line with the wire. Care should be taken that the lead-in is attached at the exact center.

5. Where a long span is not possible, or where it is intended later to install a transmitting set, a multi-wire aerial is preferable. This type consists of four or more wires strung between spreaders and separated for from two to three feet. All the wires are connected at one end and one wire is carried into the house.

All types of aerials, excepting the indoor loop, should be suitably protected with approved lightning arresters.

The experimenter buys tubes, sockets, condensers, inductance coils, panels, cabinets, and other items as separate parts and puts them together. Usually he puts them together and takes them apart again many times an hour. But as my object was to hear something good and hear it through, I bought a receiver in which all the parts were permanently installed according to engineering data. There are many of these and a prospective purchaser can hardly go wrong if he deals with a reliable concern.

Some receivers are advertised to tune from 150 to 375 meters, some from 150 to 3000 meters, and some are claimed to cover the entire tuning range of all the transmitting stations. My first vacuum tube set had a range of from 500 to 20,000 meters. I wanted to get the government stations, even the big fellows that shoot their streams of traffic across the oceans. Most of them work on wave lengths above 1000 meters, to obtain freedom from interference.

It is doubtful whether any receiver designed to cover a large number of wave lengths is as efficient on all of them as a receiver designed to give maximum results

on a limited number of wave lengths within its more restricted range. Therefore, I would rather have a short-wave and a long-wave receiver than a single receiver designed to cover all wave lengths. I have worked with one kind that can be changed from a short-wave to a long-wave receiver by the simple process of pulling out small tuning coils and plugging in larger ones. The coils, known as "honeycomb" or "duo-lateral" coils, are wound in compact shape with wires crossing and recrossing each other. The only adverse criticism I have heard about this type is that some of the very short coils do not function as well as the larger ones.

The Advantage of Knobs

Some receivers have more knobs, switches, and handles on them than others. I have found that a reasonable number of controlling knobs is an advantage, though they puzzle a beginner. In making receivers simple, some manufacturers have sacrificed efficiency. Success with highly sensitive vacuum tubes depends upon very careful adjustment of the current that lights the filaments, the current that electrifies the plates, and that which causes the grid to hold the reles on the other two. For a single tube, then, we need several knobs or switches. For very fine tuning apparatus we need at least two knobs. Some receivers have as many as six or eight controls, which make the thing look very complicated; but it is easier to learn to operate them than it is to master the controls of the simplest automobile.

The addition of an amplifier to the single-tube outfit is a simple matter. A one-step amplifier is supposed to multiply the strength of the sounds received by from 20 to 100. A two-step amplifier multiplies by another 20 or 100. The cost of the neat little cabinets is about \$20 for each stage of amplification. Two stages are enough for

My ultimate ideal receiver uses radio-frequency as well as audio-frequency amplification. The former means amplification of the current before it passes from the antenna through the detector tube, and the latter means amplification afterward. Audio-frequency amplification is all right as far as it goes, but you cannot amplify

anything you haven't got, and there are a lot of little songs and voices that arrive at the door of your home so weakened by their long journey that they cannot push through the detector without a helping hand. The radio-frequency amplifier gives them strength to enter and then the audio-frequency amplifier builds up their energy so that they sometimes swell out in louder volume than they did where they were born.

Of loudspeakers—the devices that do for radio messages what the horn does for phonograph music—there are many. Some not only serve as megaphones, but also amplify the sound by electrical devices. A number of them are but horns with ears to which the head phones can be clamped. None that I have heard deliver music of as good quality as I can get from a phonograph. That quality which makes me forget their imperfections is their ability to deliver fresh as well as canned music. When the vacuum tubes glow dimly and mysteriously through the red windows of their little cells, my imagination drifts easily to the opera or to the radio studio where celebrated artists sing for me, their distant,

(Continued on page 94)

It Pays to Plan Your Set

ONE Popular Science Monthly reader writes us:

"In less than six months of radio experience I have bought one crystal set and scrapped it, one set of aerial equipment, which I foolishly scrapped for another, and one detector tube set, parts of which I gave away when I built my two-stage set. Also, I bought a lightning switch, and then scrapped it for a lightning arrester and a loudspeaker, for which I soon substituted a phonograph attachment.

"Now I have dismantled the whole thing, and am planning to assemble a new set, along the lines of the blueprint in Popular Science Monthly. This will involve the purchase of extras costing in the neighborhood of \$20. My scrapped material represented a waste of at least \$30." J. N.

Armstrong Perry writes this article to help you avoid such experiences.

© U. S. U.



This "talking valise," invented by F. W. Dunmore, of the United States Bureau of Standards radio laboratory, is a striking example of the compact simplicity and neatness obtainable in a radio receiving set when it has been intelligently planned and assembled.

Radio Broadcasting Invades New Fields

Scattered Thousands Hear Entire Church Services, while Voices from the Air Brighten the Days of "Lifers" in Prison

IF THE radio broadcasting station recently installed in the First Baptist Church of Shreveport, La., had sufficient radio power to reach Jackson, Mich., it would be possible for 1800 convicts of a penitentiary to listen to entire church services. For while the Rev. M. E. Dodd, of Shreveport, has arranged for the broadcasting by radio of all his Sunday sermons, Warden Harry L. Hulbert, of Jackson prison has made broadcasted wireless entertainment available to his "time men" and "lifers" under his honor system.

Radio in churches is not particularly new, but the Shreveport church offers the first instance of an attempt to make radio broadcasts a regular part of the extension work. In that section of the country it is impossible for many families living in distant outlying districts to attend church regularly. Broadcasted sermons, choir music, and chimes make the church services available to scattered thousands.

1500-Mile Radius

The antenna of the Reverend Dodd's church radio outfit is strung from a 10-story tower that adjoins the church and houses the various church societies. In this same tower is located the 200-watt generating plant that supplies the power for the transmitting vacuum tubes. This broadcasting set, in charge of a



The broadcasting station of the First Baptist Church, Shreveport, La., showing the auditorium and tower with wiring, antenna, and generating plant. Inset—The pastor's mother, in Tennessee, listening to her son's sermon



At the end of the day, convicts in the Jackson, Mich., penitentiary listen to radio news and entertainment. Three receiving sets have been installed

licensed commercial operator, will have an outside radius of 1500 miles and will rank with the best stations in the South.

Perhaps the most intensely interested of the radio audience is the pastor's aged invalid mother, miles away in Trenton, Tenn. Until the installation of the church radio set she had not heard her son preach for several years, but now when Sunday comes around she can listen to his every word almost as clearly as if she were sitting before him in his church.

Convicts "Listen In"

Eight hundred miles away from Shreveport, in the town of Jackson, Mich., is a colony of 1800 men whose only contact with the outside world before the coming of radio into their daily lives, were the infrequent visitors and the still more infrequent letters. They are the inmates of Michigan's "pen."

Impressed by the possibilities of radio as a means of brightening the days of his men, Warden Hulbert decided to install radio sets in the prison and its buildings. He placed one outfit in the main prison, another at the brick-yards where hundreds of men labor under the honor system, and a third set at the clay pits where still other groups of trustees do their daily stint while working out their sentences.

Now there's radio news and entertainment within the dark gray walls and there's radio on the farms and at the clay pits. Every evening this imprisoned army of men listens in on the outside world.

Far removed from either of the two radio installations just described, but as interesting in its particular field, is the radio equipped delivery wagon of a Philadelphia bakery.

The outfit consists of four wires spread on short masts over the top of the closed-in body. Taut anchors at all four corners prevent the wires from whipping in the wind when the truck is in motion. A lead-in carries the electric impulses through the roof of the truck and to the three-stage amplifier receiving set. A loudspeaking horn has been added for the purpose of entertaining customers en route. When the truck is on one of its trips, any official of the bakery can get into instant communication with the driver by calling up a Philadelphia broadcasting station and asking the radio operator to call the truck. Up to the present no transmitting equipment has been carried, hence the truck operator is unable to acknowledge the instructions by radio, but he can and does acknowledge them at the nearest phone booth.



With wires strung above the roof, and a three stage amplifier receiving set, shown in the inset, this Philadelphia delivery truck picks up messages from its office, including instructions for last minute deliveries

On the Crest of the Radio Wave!

By Jack Binns

America's First Wireless Hero and Most Famous Writer on Radio



Jack Binns broadcasts monthly the essential news of radio to the readers of *Popular Science Monthly*

How a Receiving Set May Become a Transmitter

The Secret of Talking to Ships and Trains



Who Will Invent a Radio Valve?—Use Squeals in Tuning

THE other day, in a downtown lunch-room where I was snatching a hurried midday meal, a tall, angular, and somewhat nervous man sat down beside me with a tray of food. Just before he began to eat, he pulled out a daily paper, tore off the radio program, and began to study it intently.

A little later, he looked up at me nervously then ventured:

"Have you got a radio set?"

Before I could reply in the affirmative, he continued:

"I've got one. Made it myself. I live in Boston, and I'm a fireman there. You know, it's just a homemade affair. I get a lot of fun out of it. It's just a crystal set."

A Strange Whistle

"The other day, though, I had a funny experience when I was listening in with a friend. I heard a peculiar kind of whistling that kept up a long time, going up and down the scale. The wind was blowing strong outside, and the other fellow said the whistling was the breeze blowing through the aerial. I told him I didn't think so, but that the noise must be caused by sun spots, or else by Northern Lights. He wouldn't believe me."

"A few nights later the wind was blowing hard again. I listened in with the other fellow, and we didn't get that whistle at all. I said to him, 'There you are, now. It isn't the wind at all. It must have been Northern Lights.' I guess I was right."

As he finished, the nervous man looked up with an air of triumph.

"Well, that's very interesting," I said, and meant it, too, because I realized suddenly how puzzling to many radio fans some of the common experiences of radio must be, and how erroneously these experiences are sometimes interpreted.

Before my lunch-table acquaintance could say anything more, I asked him, "Is there anybody else in your neighborhood who has a wireless set?"

"Oh, yes," he replied, "there's a fellow two blocks away who has a regular set, and he's just put in two stages of amplification. It's a regenerative set."

"When did he put his set in?" I inquired.

"Oh, about the time I got the funny noise I was telling you about."

"Well, then, that accounts for your whistling noise," I explained. "I'll tell you just what happened. You know when the broadcasting station starts up, its transmitting set sends out a train of continuous waves. These waves act as a carrier for the voice currents, and they spread out in all directions, as long as the transmitting set



Thousands of students as far south as Florida and as far west as Wisconsin, heard college courses by radio when leading members of the faculty of Tufts College, Medford, Mass., recently volunteered to broadcast lectures on their respective subjects from the American Radio and Research Corporation's plant at Medford Hillside. Four of the pioneer professors in this new enterprise of educating a whole countryside by radio from one college are shown above, in the broadcasting station, with Dean Gardner C. Anthony seated at the table, reading his lecture.

turned on. The chap who has a regenerative set has the same kind of an apparatus, in a miniature form, as that in the broadcasting station. His set, when he turns it on, also becomes a small transmitting set, capable of sending out weak, continuous waves. In adjusting his set, he made it "heterodyne," or clash with the broadcasting station, and so caused it to squeal, or whistle. That was what you heard on your crystal set. Such noises occur every day, when a fellow puts too much current through the filament of his vacuum tube detector, in a regenerative set. It doesn't help him, and it causes some interference to others around him."

"Gee," said my chance companion, "that's the best explanation I've heard yet. You seem to know. You must be a wireless man."

A Great Chance for a Young Inventor

THE foregoing paragraphs may explain to some of my readers one of the things which has been causing them trouble ever since they took up radio. The condition arises most frequently in larger cities, where, on some apartment-house roofs, you will see as many as seven or eight aerials attached to different sets in the apartments below.

"How can a receiving set possibly become a transmitting set?" you ask, quite naturally.

Waves from a Receiver

The answer is simple enough. A regenerative receiver in order to "feed back" energy and build up, or amplify, the weak incoming signal, causes the vacuum tube to oscillate. In other words, the receiver produces oscillating magnetic waves, which will have the wave lengths of whatever particular adjustment the receiving set is tuned to at the moment the vacuum tube begins to oscillate.

Now if the receiving set "heterodynes" upon the carrier wave of the broadcasting station—I'll explain that in a moment—there results a well-defined howl, or squeal, so familiar to the radio amateur, which will be recorded on all

sets in the neighborhood, including the crystal detector sets.

The heterodyning effect is caused in the following manner: In the first place, we know that the electromagnetic waves used in radio transmission and reception travel at the rate of 300,000,000 meters a second. Therefore, if we know the wave length of a station sending out continuous waves, we shall know the rate at which they oscillate. For instance, the broadcasting station operating on a 360-meter wave will have a frequency of approximately 830,000 cycles a second. This is determined by dividing 300,000,000 (which is the speed of the waves) by 360 (which is the length of the waves).

Now, when a receiving set is also oscillating and sending out electromagnetic waves, it may happen that it will not be exactly

in phase with this frequency. In other words, suppose the receiving set were oscillating at 831,000 cycles a second. The result would be that its waves, and those from the broadcasting station, would clash 1000 times every second; and vibrations at that rate produce a shrill noise that may cause inconvenient interference.

This interference is an interesting problem, and one that offers a big scope to the radio novice and amateur of inventive turn of mind. I was speaking about it the other day with John F. Grinn, one of the most famous of amateurs—the first man to send a message across the continent, and also the first to send across the Atlantic Ocean with amateur equipment.

"What is needed," he said, "is a one-way repeater; something that will allow the incoming waves to pass down the aerial and be recorded in the telephone receiver, but that will prevent the local oscillations from getting to the aerial. In other words, what we want is a wireless valve. Here is a great chance for some young inventor, and I am quite sure he will come along, some day, and cash in on it."

So am I.

Why Not Use the "Squeal"?

A YOUNG chap came to me the other day, and said: "There is always a terrific grinding noise in my telephones. I am using a regenerative vacuum tube set. I've tried to get rid of the noise, but without success. All the sets I have listened to have the same trouble."

I am mentioning this because I have found the "grinding noise" is a source of trouble to most novices who have regenerative sets. They become discouraged, and because every one else they know is experiencing the same difficulty, they feel the trouble is inherent in that particular type of apparatus.

Foreign Noises Are Unnecessary

As a matter of fact, any extraneous noise in the telephones is unnecessary with a set of this kind—except in the case of the poor unfortunate who lives next door to an ambitious amateur with a one-kilowatt transmitter, who believes the ether was created for his own particular enjoyment.

When the noise is of the "grinding" or "frying" type, usually the trouble can be found in loose connections. Don't take anything for granted. You may feel sure that all your connections are securely made, but don't rely on your feelings. Make sure that each connecting wire is tightly screwed to its terminal.

If you find the wires are secure, yet you still get those grinding noises, the trouble must lie in your B battery, in which case I would suggest that you buy a new one. By the way, when I said, "Look over your connections," I referred also to those inside the cabinet.

There is another noise that is probably more frequent in regenerative sets. That is the "howling" or "squealing" noise. In-

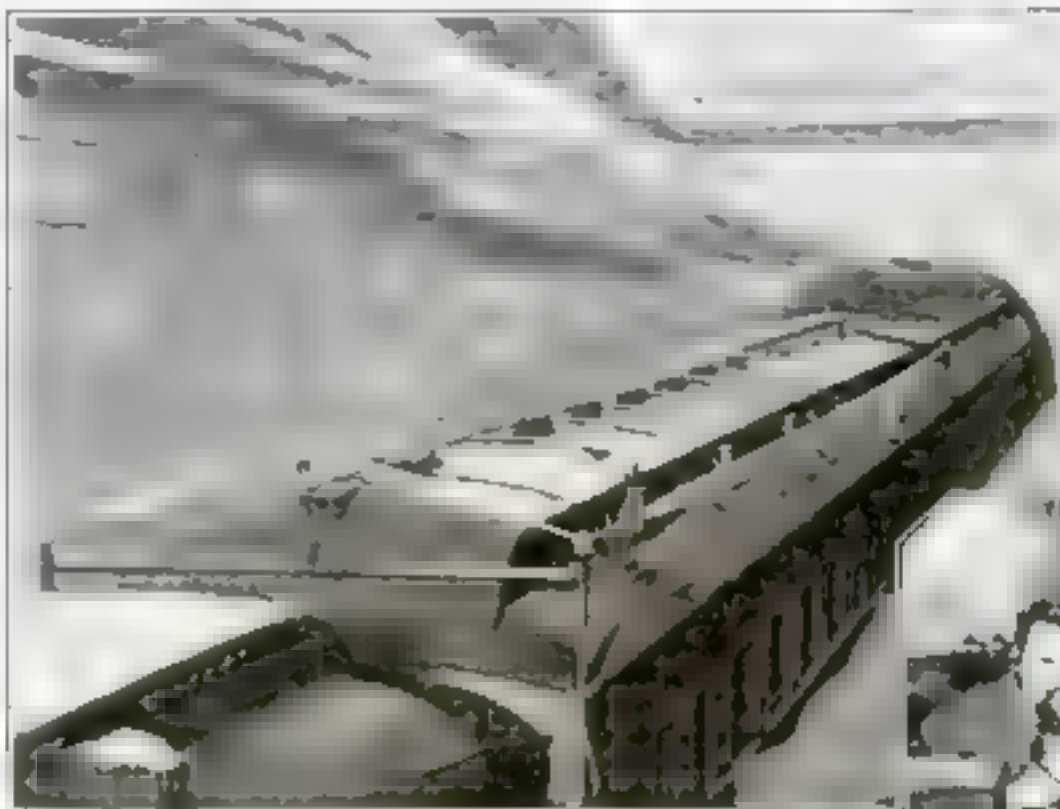
variably this is due to the manipulation of the set by the novice. If you pass too much current through the detector and amplifier vacuum tubes, you will always get howling, or squealing.

This brings me to an important tip. It is important enough to merit a paragraph to itself.

Music and speech are received most strongly and most clearly at the adjustment JUST BELOW the squealing or hissing point of your set.

Don't forget that.

Here is another important thing to remember: If your set has a "vernier" ad-



The train's radio equipment was a six-wire, 4-inch aerial 18 inches above the car, connected with a two-step receiving set. The transmitting equipment was a set with a maximum radius of 50 miles. Reception and transmission under normal conditions were said to be almost perfect.

During recent tests in which a speeding Lackawanna express train kept in touch by radiotelephone with stations miles away, an Eastern railroad demonstrated that a train in a long tunnel, could receive messages almost as clearly as in the open. Operators are shown below receiving and sending messages in the buffet car.



justment handle, you can eliminate all hissing and squealing by carefully and very slowly adjusting this handle until the hissing disappears.

One of the peculiar things you will experience about the humming is this: If you turn the vernier handle around, you will find that the humming varies in its tone. In other words, it will start from the bottom and go up to the top of the scale. Then it will stop, and a little farther on will start from the top of the scale and go down to the bottom. The point to aim for in the reception of music and speech is the point between the time the humming reaches the top of the scale and the time it starts to descend. This is the best adjustment you can get, and it is known as the critical point.

Another thing: On your detector B battery, don't forget that all vacuum tubes are not alike, and some require less plate voltage than others. Therefore, so far as the detector tube is concerned, it is better to put in a variable B battery, so that you can take off taps from different voltages below 22½ volts. This is not necessary for the amplifier tubes.

How You Can Phone to a Friend at Sea

AT THE present moment, when the genius of the country is concentrated upon the development of radio receiving apparatus to improve the concerts that nightly are being sent through the air, a set of experiments equally important is

being prosecuted. These experiments have to do with the application of radiotelephony to the ordinary pursuits of man, in business as well as in pleasure.

Inventors have already developed a system whereby the radiotelephone can be connected with the ordinary telephone lines, so that a person may sit at ease in his home or in his office and communicate with a passenger on a ship at sea. This system is now being applied to moving trains and to aircraft flying between cities.

The great difficulty, however, has been to devise a system whereby one speaker can interrupt the other and stop a communica-

tion which is not being understood, without requiring the radio central to throw over a switch from the transmitting apparatus to the receiving apparatus. This is a difficult and serious problem. The chief difficulty lies in the fact that at the radio central station the transmitting apparatus is sending out a tremendous amount of power from the aerial wires, sufficient to communicate five or six hundred miles, under the most adverse conditions. The amount of energy received from the distant station on the same aerial is infinitesimal—in fact, it is so small that there are no measuring instruments known to man sufficiently sensitive to measure the amount of current.

One Problem Partly Solved

From this, you may readily understand how great is the problem of making this minute incoming current interrupt and stop the powerful current that is being sent out from the same aerial. The problem has been solved to a certain extent in two different ways, both of which are based on the same general principle.

One of these methods was used in the tests recently carried on between an experimental station in New Jersey and the steamship America at sea. It consisted of establishing the transmitting station in one locality and the receiving station a few miles away. But even with the stations this far apart, the radiated energy from the transmitting station is impressed upon the receiving antenna with great intensity. The method of enabling the weak incoming signal to stop the powerful outgoing voice

by balancing the transmitting against the receiving circuit. Included in this balance is the land line circuit connected with the radio circuit.

The other solution is to divide the antenna at the radio center into two sections—one for receiving and one for transmitting, and then to utilize the balancing arrangement in the same manner. This balancing is controlled by a coil, which has been named the "hybrid" coil.

As a result of the radiotelephone tests with the *America*, many of our radio novices stuck their chests out with pride, because of the great distances from which they imagined they had heard signals. They all distinctly heard the experimenter on the *America* announce that he was 800 miles from shore. In fact, they heard him each night of the tests—that is, they thought they heard him. As a matter of fact, what they actually received was a re-radiation of his remarks from the transmitting station at Deal Beach, New Jersey. The manner in which this re-radiation occurred was as follows:

Incoming Current "Spills Over"

The "hybrid" coil, not having been adjusted 100 per cent perfect, permitted a slight amount of the incoming current to "spill over" into the transmitting side of the balance. The consequence was that this excess amount of current passed through the amplifiers in the transmitting station, thence through the oscillator, and finally radiated from the aerial. What the novice received was this re-radiation.

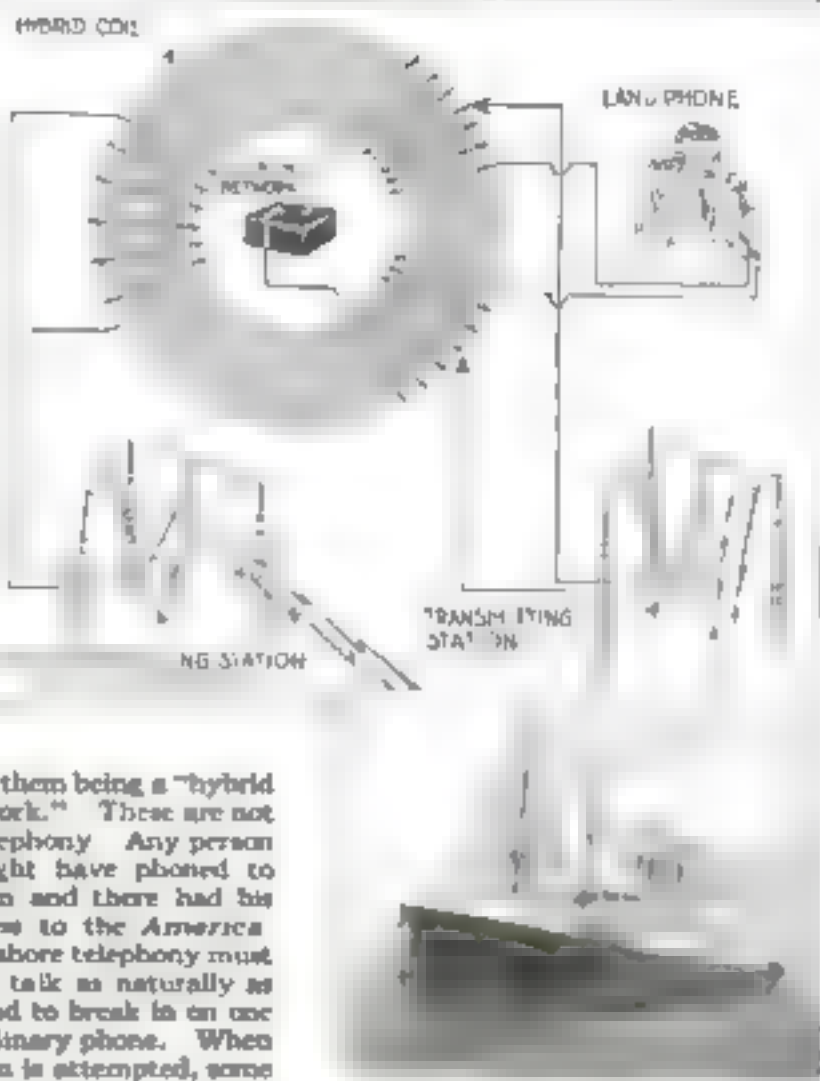
So far, this balancing method has been very successful in communicating with ships at sea and with aircraft, but it has not yet been applied to moving trains. Direct two-way conversation between moving trains and stationary points is still a thing of the future. However, an interesting result of recent tests with radio on the trains of the Lackawanna Railroad is the confirmation of many theories in connection with certain directional effects of aether. The tests also demonstrated the ultra-sensitiveness of the vacuum tube as a detector and amplifier, for speech was readily received while the train was inside a 4283-foot tunnel and also while it was underneath the steel-enclosed terminal in Hoboken, N. J. In perfecting radiotelephone communication with moving trains,

How a Two-Way Radio Talk Is Possible

BY USING the well known principle of the Wheatstone bridge, illustrated in the accompanying diagram, radio engineers recently were able to carry on a two-way conversation by wireless telephone with the steamship *America*, 400 miles at sea. The ship was picked up by radio operators at Deal Beach and Elberon, N. J., where wires from the land phones were joined to the radio equipment.

Complicated wiring and many sensitive instruments were employed in the ship to shore demonstration, chief among them being a "hybrid coil" and a "balancing network." These are not needed for one-way radiotelephony. Any person on shore, for instance, might have phoned to a radio transmitting station and there had his speech conveyed via wireless to the *America*. But to be a success, ship-to-shore telephony must permit the two speakers to talk as naturally as if they were face to face, and to break in on one another just as over the ordinary phone. When such a two-way conversation is attempted, some method must be found to prevent the tremendously heavy currents of the radio transmitting station from working back in the land phone.

The hybrid coil and balancing network which accomplish this, consist of an arrangement of coils and condensers that filter out the undesired electric impulses and allow the essential ones to pass. When the balance is perfect the trans-



mitting station can send the speaker's words through the air with as high a power as is necessary without its working back to affect the operation of the land phone. This makes uninterrupted conversation possible.

one of the problems that wireless engineers must contend with is that of "radio pockets."

It has been known for some time that mountain ranges form a very strong screen to electromagnetic waves, and that on the opposite side of these mountain ranges there exists for a certain distance a wireless "pocket" in exactly the same manner as there would be a "pocket" of calm air on one side of the mountain if a terrific wind

were blowing straight at the mountain from the other side. As in the case of the wind, however, this "pocket" extends only as far to the rear of the mountain as the shielding effect exerts its influence. The diffraction of the electromagnetic waves permits them to come together in the rear of the mountain and carry on to infinity, leaving only a small "pocket" in which there can be no reception.

Five-Ton Truck Carries Complete Road Repair Equipment

COMPLETE equipment for highway maintenance has just been designed by Stanley Abis, of Kern County, Calif., in such a compact form that it can be carried upon a single five-ton truck. The unit carries machinery and supplies for practically all varieties of road repairs. It will repair bridges, erect fences, put out fires, and fix breaks in any sort of road surface, whether of concrete, reinforced concrete, or macadam.

The important parts of the equipment are a material bin, holding cement, rock, and sand,



How the repair equipment, including concrete mixer, power winch, grading plow, hot-tar sprayer, and material bin, is assembled on the truck

and a small concrete mixer complete, even to the water tank. There is an air compressor to operate the sprayer, a power winch, a grading plow, a spray paint outfit, a hot-tar spraying device, an oxyacetylene cutting and welding outfit, and a post-hole digger.

Power for all these tools—eight in all—is derived from the truck engine, and no auxiliary motor is carried. The power shafts are rotated at various speeds, according to the tool being used, by seven-speed compound transmission controls.



The Home Workshop

New and Useful Things for the Practical Man to Make

How I Earn Extra Money Making Socket Wrenches

The Story of a Mechanic Who Is Turning His Skill with Tools to Spare-Time Profits in a Novel Way

Wrestling Wrench-Maker Wins in Tool Contest



Peter Petkoff

THE writer of this article, which wins first prize in the contest, "How I Made Money with My Tools," estimates that he has earned about \$400 from a year's sale of the wrenches he makes in odd moments.

To wrestling fame in Minnesota, North Dakota, Wisconsin, Iowa, and Nebraska he is known as Peter Petkoff, "the Bulgarian wonder."

He was born in Bulgaria in 1894, had the equivalent of an eighth grade education in the town of Rusuk, and was brought by his father to the United States when he was 13 years old.

"The balance of my education," Mr. Petkoff writes, "has been picked up here and there through observation, including my knowledge of the English language, of which I knew nothing when I landed in New York."

"My first employment was in a foundry at Pittsburgh, where they almost worked me to death. From there I took a long jump, going to Duluth, Minn., where I worked for transportation companies, railroad and steamship, in different laboring capacities. In 1917 I met an attorney who advised me to go into the automobile business and I have been at the mechanical end of the business ever since. I went into the industrial army during the war and helped build gas, electric, and steam hoisting engines. In 1920 I went to work for the Payne Motor Co., Minneapolis, Minn., where I am still working and still making wrenches in my spare moments."

By Peter Petkoff

Winner of First Prize in Contest, "How I Made Money with My Tools"

I AM an auto mechanic who never had much patience in wrestling with the nuts and cap screws hidden away in so many mean places around the average machine. So I started to make wrenches that would get into the out-of-the-way parts with ease—wrenches that would turn corners.

After I had made a set of the wrenches, the boys in the shop saw how they worked and the time and effort they saved. They promptly asked me to make some of the wrenches for them. This I did, and soon found myself making an average of three a week.

On the photograph I have numbered the wrenches from 1 to 13—an unlucky number, but I am not superstitious!

The socket of wrench No. 1 was made from a wristpin, while those I am now making are from wrenches of a certain brand that are the best on the market, so far as I know, from which one can make a universal-joint socket wrench. Making sockets out of wristpins takes up much more time than buying the readymade sockets at 35 cents apiece and cutting them up. I am, therefore, really making more wrenches and more money by my present method.

The other parts I use for a wrench like No. 1 are as follows: a piece of 7/16-in. square key steel for the joint block, a piece of 3/4 by 1 1/4 in. round tool steel for the joint

between shank and handle; a piece of 7/16 by 12 in. cold rolled iron for the shank; a discarded oil-pump plunger, already drilled, for the top of the shank; and a piece of 3/4 by 8 in. cold rolled iron for the handle. The joint block, shank and handle are pinned through with 5/32-in. drill rods,

five pins in all being required for the job.

The explanation of the wrenches and parts on the photograph is as follows:

1. A wristpin socket wrench for a 3/4-in. cap screw.

2. A 3/4-in. wrench with joint block of 7/16-in. key steel.

3. A 3/4-in. wrench for spring clip nuts made from two T-handle wrenches.

4. A 3/4-in. cap screw wrench which has a double-jointed universal socket and is intended for getting around corners. Two wristpins are required for this.

5. A 3/4-in. wrench made from a discarded oil-pump plunger.

6. A 3/4-in. cap screw wrench made from a commercial wrench, with an old oil-pump plunger for the top of the shank, 3/4 by 5 1/4 in. cold rolled iron for the handle.

7. A 5/16-in. wrench for cap screws.

8. A 3/16-in. wrench for couplings.

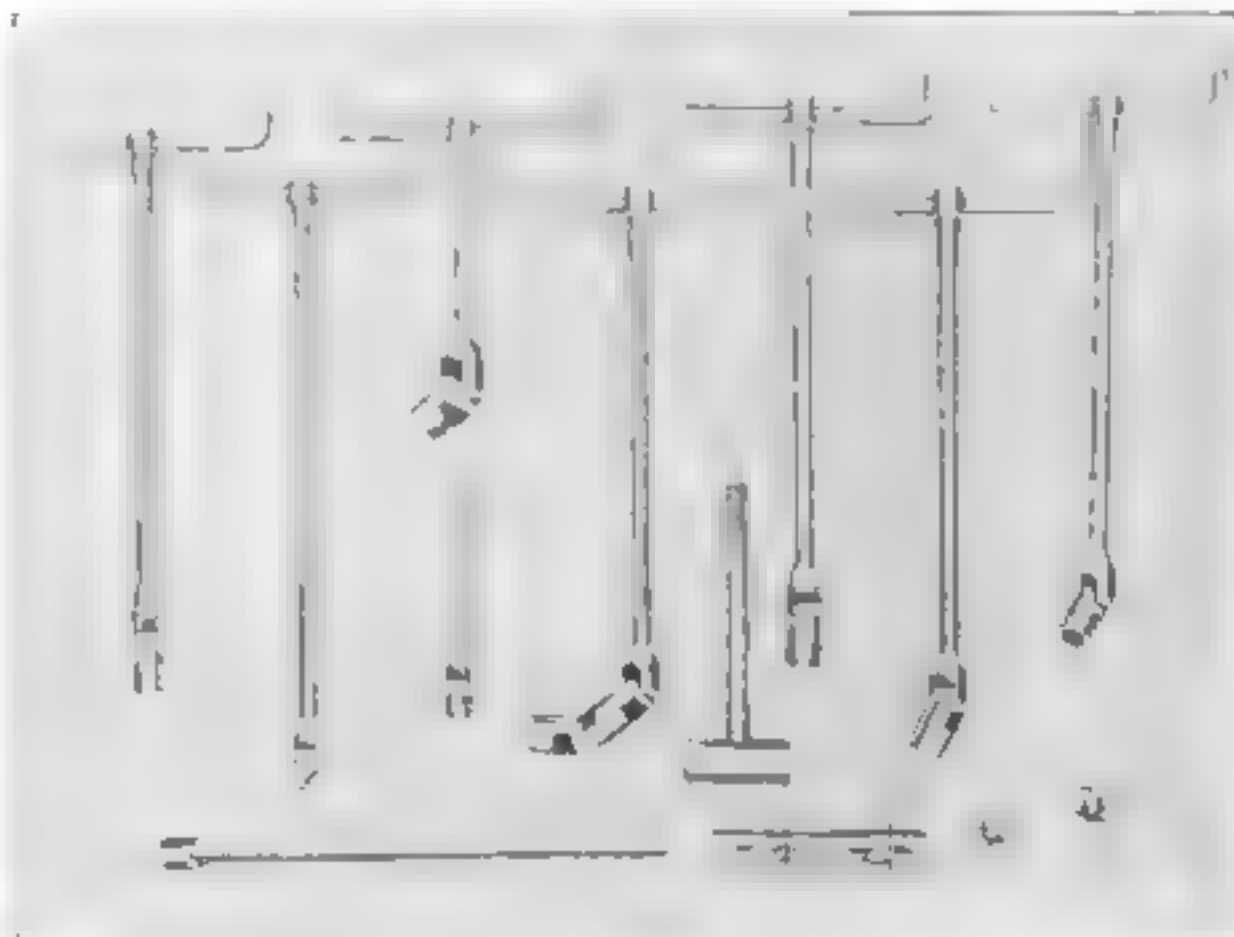
9. Wrench made from a wristpin. The sockets are formed by putting two or three nuts of the desired size on a stud or cap screw. After the wristpin has been heated, the nuts are driven in and the outside of the socket end is hammered all around.

10. A commercial wrench cut for a universal 5/16-in. cap screw wrench.

11. An oil-pump plunger, showing where it is cut for use as part of wrench No. 6.

12. A 3/4-in. joint block.

13. A 5/16-in. socket, from the joint side.



Socket wrenches for automobile repairmen made by Mr. Petkoff. Number 4 has a double universal joint to permit tightening cap screws in inaccessible corners.

Originality Marks the Prize-Winning Contributions for July

THE outstanding feature of the three prize-winning contributions in the contest, "How I Made Money with My Tools," is their originality. None of the writers is following ordinary methods in earning extra money with his tools. And just as unmistakably the work of each man shows him to be gifted with exceptional mechanical ability.

The majority of letters submitted told how the writers are making money in many varied but more usual ways, and the best of these will be published in following numbers of POPULAR SCIENCE MONTHLY.

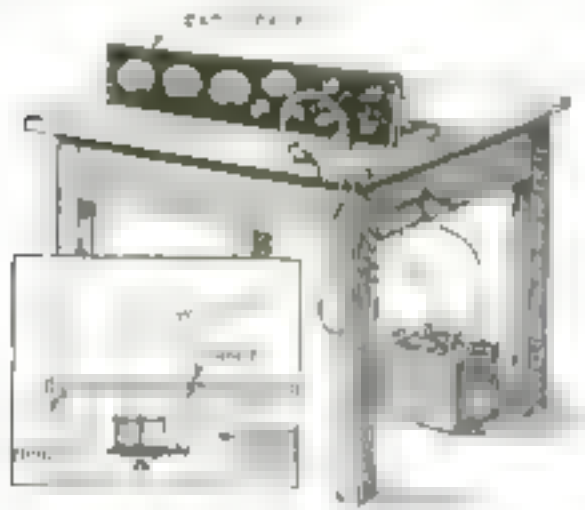
How to Build a Radio-Phone Set into a Library Table

By Neal W. Sanders

FOR one of the boys in a sanatorium who had but limited space in his bungalow, I made the library table for a radio set as shown in the accompanying illustration.

The top is 24 by 30 in. and the legs 2 in. square and 28 in. long. The top is in two pieces, the back being fastened solidly to the rails and the front hinged.

The base of the instrument panel is also hinged at the back so that it may be



When not in use, the panel turns under the table top, as shown in the diagram.

lowered out of the way or raised for operation. When the panel is dropped beneath the table, the table-top is entirely clear and can be used for its ordinary purposes. The edge of the base, it will be seen, then makes part of the top.

When the panel is on the table in place for receiving, the 3-in. space between the two halves of the table top permits the wires from the A and B batteries to come up from the back, thus keeping them neatly out of sight.

By tacking a 6 by 8 in. board flush underneath the top at the back, a shelf is made for the B battery.

Removing Borings with a Magnetic File

IN CASE a drill is not long enough to carry the borings out of a deep hole, they may be removed easily by inserting a magnetized rattan file into the hole. The file can be magnetized by placing it on the face of a magnetic lathe chuck or on the field of a generator for ten minutes. It will hold its magnetic power for several days.

I used this method successfully in cleaning out the holes bored in some very heavy steel rods.—A. E. SMITH.

Blacksmith Carves Miniature Portraits

By D. J. Spencer

(Second Prize, "How I Made Money with My Tools" Contest)

I HAVE been a blacksmith for 41 years and until a year ago last September I never had time to indulge my great desire to carve. Being out of a job for a few days, I began carving a small sparrowhawk, then an eagle, then a group of four eagles, called the "Feast of the Eagles." Next I carved the figure of our old dog.

The work must have seemed realistic, for every one was so appreciative that I felt encouraged to attempt miniature portrait work. My first study was a small head of the immortal Lincoln. Then I carved the then President Wilson and several local residents, and made a few animal studies. Among the latter was a lion carved from coal, which weighed approximately 400 pounds.

I have carved more than 220 pieces. To show that fine tools were not necessary, I carved one Lincoln out of what is known as Utah mahogany about one quarter life size with a three-pound hand ax, never touching the wood with another tool. The offer of \$50 for this bust which I refused shows the scale of my profits from this work.

Life-size portraits of Lincoln, Washington, and Okuma, late Japanese Premier, were carved in Utah ruby sandstone. The head of Okuma took 23 hours to complete. One of his fellow countrymen who knew him well said it was an excellent likeness.

Most of this work has been done at night and for the love of it, although I find ready sale for the carvings, and have picked up a tidy little extra income from them.

Among the compositions I have attempted is a mother and child carved from a single piece of wood about 6 by 6 in. The mother is sitting in a rocking-chair with her baby's head on her bosom. Another subject, in stone 6 by 9 in., is a pioneer rising from his blankets with his gun in hand and two alert dogs at the foot of the bed.

The way to do this work, I find, is to visualize some object in the rough block and then make the hand cut away the outside until the form is revealed. Study for power, poise, and proportion. If you are carving, do not model in wax or clay, the two processes, to my mind, are the antithesis of each other, and

carving is the greater art. Study means of expression by carving soft substances.

I gave a dinner recently and the baked potatoes were each a miniature of a character from the comic papers.

Although I liked to make pencil sketches when a boy, I had no training in art. In fact, I never saw any woodcarving—except the old-fashioned Indian standing watch in front of a cigar store—but in my visits to art museums I have seen the work in stone and bronze of some of the recognized masters.



Character study of a neighbor carved in wood and gilded.

Turns Sculptor after Lifetime at the Forge



D. J. Spencer with study of Venizelos.

WITHOUT ever having read a book on carving or taken a lesson in art Mr. D. J. Spencer, of Price, Utah, who has spent a lifetime at the forge turned his hand to sculpture in September, 1910. He is now working on a series of portrait busts of famous

men and has carved Lincoln, Washington, Jefferson, Roosevelt, Wilson, President Harding, and Venizelos.

The fact that Mr. Spencer makes no preliminary studies in clay or wax gives his work an unusually interesting aspect from a technical standpoint. The usual method of carving any hard substance, whether stone or wood, is first to make a model in plastic material, then a plaster cast, and finally, by more or less mechanical measurements, a carving that may or may not be touched up freehand by the original sculptor. Mr. Spencer follows no

such indirect method; he carves from the block freehand, with nothing to guide him but his eye, and uses the ordinary tools that can be found in any average home workshop. This simplifies his work so that he can carve with comparative rapidity and therefore earn more than would be possible if the slower, more roundabout process were used.

His ability with tools is reflected in his success as a blacksmith. Some of the records he holds have rarely been equalled. Last summer he is said to have sharpened 240 cutter bits in one hour and he has done 1600 in eight hours, day in and day out, as compared with the average smith's rate of from 400 to 600 a day. In his time he has shod more than 45,000 horses.

Mr. Spencer has an enviable ancestral record; he comes from old Revolutionary stock—his great grandfather fought through the Revolution, his grandfather fought in the War of 1812, the second Seminole Indian War, the second Black Hawk War, and the Mexican War; his father in the Civil War. Born in 1865, Mr. Spencer put in brief terms of schooling in West Virginia and in Indiana, and for a time attended the Western Normal College, Bushnell, Ill. He has been married 31 years and has three children and one grandchild.

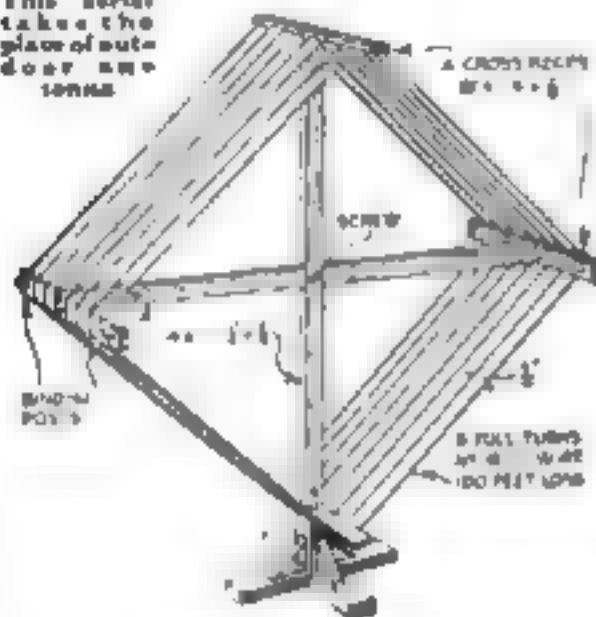
Indoor Loop Aerial Helps Overcome Summer Static

By George A. McHenry

STATIC, the bane of summertime radio-telephone reception, may be overcome in large part by the use of a simple loop aerial in place of the ordinary outdoor antenna. It will not, however, serve well with a crystal set; a good vacuum tube receiver with several steps of amplification is essential for the best results.

For making the loop aerial two pieces of wood $\frac{3}{4}$ by $1\frac{1}{2}$ in. by 4 ft. 8 in., four pieces $\frac{3}{4}$ by $1\frac{1}{2}$ in. by 8 in., 100 ft. of No. 18 cotton covered wire, 12 screws and 2 binding posts will be necessary. A base or support of some kind will also have to be constructed to permit the loop to revolve around its vertical axis, because this type

This aerial takes the place of outdoor antenna



of aerial is highly directive and should be turned so that its horizontal axis points in the direction of the transmitting station.

Assemble the frame as shown and wind on eight full turns of the wire, spacing the turns $\frac{3}{4}$ in. apart. Connect the ends with binding posts, from which run wires to the aerial and ground posts of the receiving set.

Even better results will be obtained if the loop aerial is connected only with the aerial binding post and a regular ground connection made with the ground terminal of the set.

The adjustment of the set may be made more delicate by taking tape off each turn of the loop aerial to permit the regulation of its inductive value and by shunting a variable condenser of .0005 microfarad maximum capacity across the active turns.

The advantages of the loop aerial in overcoming static disturbances, in reducing the interference of other stations to a minimum, and in making unnecessary the cumbersome outdoor antenna, are obvious. On the other hand, reception with a loop is not possible for so great a distance as with an outdoor aerial, and a more elaborate set is required, adding to the first cost of the installation and its subsequent upkeep.

Motor Brush Cleans Typewriters

THE typewriters used in a shipping office over a large warehouse were in almost constant need of cleaning, especially in the summer, until a special machine method of brushing them off was adopted. The cleaning was done by means of a small circular brush mounted on a flexible shaft connected with an electric motor, which would be plugged in the nearest light socket. This eliminated the drudgery of hand dusting, saved time, and reduced repair bills.—DALE R. VAN HORN



Bench Talks

Making Your Home Workshop Pay Large Dividends

By Arthur Wakeling

ANYBODY who had the privilege that has just been mine, of reading hundreds of manuscripts submitted by readers of POPULAR SCIENCE MONTHLY in the Home Workshop's "How I Made Money with My Tools" contest, would be amazed at the variety of ways in which mechanical hobbies may be made to pay cash dividends.

I had always assumed that most men who work at home with tools do so because they find it a mint of fun and recreation, with by-product savings in bills for upkeep, repairs, and new furniture. But the readers' letters that I have just read convince me that the average home workshop, and the hours of healthful amusement spent in it, can be turned into nice little cash profits by the enterprising tool user.

Some of the contestants even built their own homes as the direct result of the experience and confidence they had gained in their work with tools. One of them, who put up a house chiefly with the aid of his wife, is a clerk and never worked at a building trade. Others turned their efforts toward remodeling old places they had purchased at comparatively small cost.

Selling Home Workshop Products

The larger number of writers told illuminating and most encouraging stories of how they had added to their income by making things in their spare time. The product of their workshops range all the way from automobile bodies to xylophones. Many found profitable and ready sale

for special furniture, toy furniture, toys of all kinds—wood, metal, and electrical, novelties, electrical devices, tools, models, objects of art, wood turnings and carvings, craft work, ornamental metalwork, jewelry, and an infinite variety of other products of the home workshop.

Repair Work Proves Profitable

Numbers of others made extra money with repair work of one kind and another. One man made a specialty of replacing worn automobile runningboards; another bought second-hand gas engines, repaired and painted them, and resold them at a profit; a third bought and overhauled electric motors, selling them to such advantage that he was able to equip the second floor of his garage with a considerable assortment of machine tools and woodworking machinery. Repairing furniture and upholstery, fixing broken toys, and mending electrical appliances are the spare-time occupations of other home workers.

Among all the contributions to the contest, no two were exactly alike. Their diversity proved that the home workshop can save and earn money in countless ways if ingenuity is combined with perseverance and if the right market is found. Many of the most interesting letters will appear in following issues of POPULAR SCIENCE MONTHLY. Watch for them all. They will bring you inspiration, amusement, and helpful suggestions that you may turn to your own profit.

Celebrate a Safe Fourth with Carbide Cannon

By A. L. Long

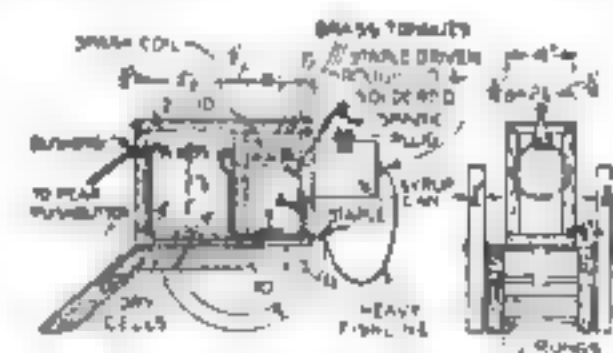
NOISE is plenty for celebrating the Fourth of July can be made with an electric carbide cannon. Not only is such a cannon safe, but the ammunition costs next to nothing, is easily obtainable, and produces a surprising volume of sound.

The most expensive part of the cannon is the coil. The one used in making the cannon illustrated is a Ford coil, and any Ford owner can readily borrow a coil from his machine when the cannon is to be used. Dealers in second-hand auto accessories usually have old Ford coils at a reasonable price.

The gun carriage is a wooden box for holding the coil and dry cells mounted on two wooden wheels. A syrup can $3\frac{1}{2}$ in. in diameter and 4 in. high should be mounted as shown with wood screws and a bolt run through the front of the box to a brass tongue for making the ground connection. A spark plug is screwed into the upper part of the can and connected with the coil as indicated. The tight fitting can cover is tied to the gun carriage with heavy fishline or strong cord so that the explosion will not blow it into space.

Provide a small oilcan to contain the water used in charging the cannon. To charge, release the back rest and allow the cannon to swing muzzle up. Place from six to eight grains of pea carbide in the can

and moisten it with several drops of water from the oilcan. The gas will form immediately, so push down the lid tightly at once. Fire the cannon from a distance by

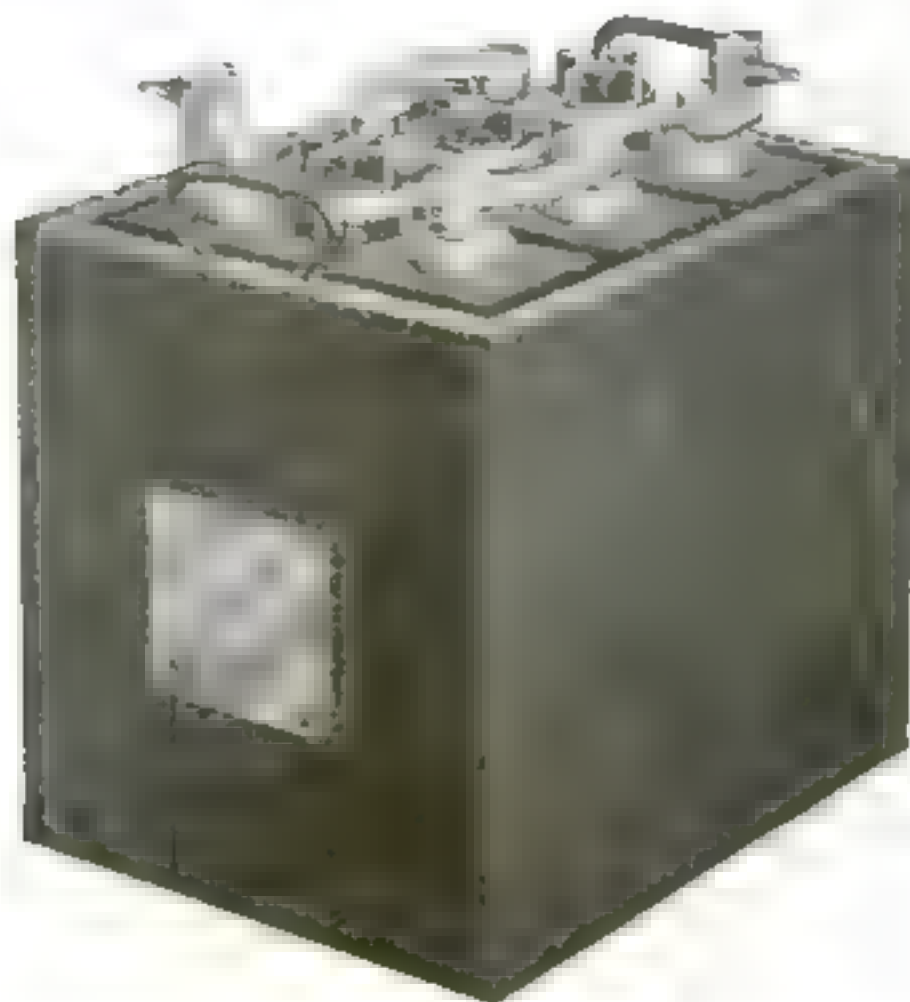


An electric spark from this motorcar

pressing a pushbutton at the end of a flexible lamp cord.

The report will be equal to any cannon cracker on the market. Several explosions may be obtained from one charge if water is added each time. As soon as the carbide appears to have become powdered, clean out the can and recharge with new carbide. Fifteen cents' worth will be enough for an all day's celebration.

The cannon will be more realistic if painted to look like a miniature piece of artillery. With a little ingenuity, coast or railroad artillery pieces may be imitated.



The Kind of Battery for Radio Service

TO get real satisfaction from your radio outfit choose a battery that you don't have to fuss with. Even if you know nothing about batteries, the Exide name is your guarantee of first quality and dependable, lasting power.

Wherever batteries must be reliable, great industries and governments throughout the world put their faith in Exide. Every time you use the telephone, it is an Exide Battery that sends your voice over the wire. An Exide transmits your message by tele-

graph. A great majority of the government wireless stations and those of the Radio Corporation are equipped with Exide Batteries.

You can get an Exide Battery specially designed for radio at every place where radio equipment is sold and at all Exide Service Stations. Any of our stations will recharge radio batteries.

Exide Radio Batteries give uniform filament current for all types of vacuum tubes. They are conservatively rated and will give full ampere hour capacity.

THE ELECTRIC STORAGE BATTERY COMPANY
Philadelphia

*Oldest and largest manufacturers in the
world of storage batteries for every purpose*

Exide

BATTERIES



The end of a perfect howl—

THE squawls of a two year old are as music to the ear beside the howling demonstration put up by a fractious radio set. And how a set can howl unless one offers the soothing influence of the proper amplifying transformer.

Most any transformer can amplify sound, but it will also amplify the stray fields which produce howling and distortion. It takes the Acme Amplifying Transformer with its specially constructed iron core and coil to put an end to the howls and yowls. Only when you add the Acme do you get the realistic tone and volume so markedly absent in the ordinary radio receiving set.

The Acme Radio Frequency Transformer greatly increases the range of any receiving set, either vacuum tube or crystal detector type. The Acme Audio Frequency Transformer produces not only volume, but reality of tone. It is indispensable to the satisfactory operation of loud speaking devices. The combination of one or more stages of Acme Radio and Audio Frequency Transformers assures the maximum of range, of volume and of reality in tone.

The Acme Apparatus Company, pioneer radio engineers and manufacturers, have perfected not only Radio and Audio Frequency Transformers as well as other receiver units and sets, but are recognized as the foremost manufacturers of Transmitting Apparatus for amateur purposes. Sold only at the best radio stores. The Acme Apparatus Company, Cambridge, Mass., U. S. A. New York Sales Office, 1270 Broadway.



Type A-2 Acme Amplifying Transformer
Price \$5 (East of Rocky Mts.)

ACME

for amplification

THE HOME WORKSHOP

Listen-In on POPULAR SCIENCE MONTHLY'S Two-Stage Receiving Set

THOUSANDS of radio amateurs have made and are now receiving broadcast programs with POPULAR SCIENCE MONTHLY'S two-stage receiving set, described in Blueprint No. 6 of the Home Workshop Service Department's series of blueprints. The set has won unanimous favor because it clearly brings in distant stations, is exceedingly sensitive in tuning, and can be made at comparatively small cost with tools found in the average home workshop.

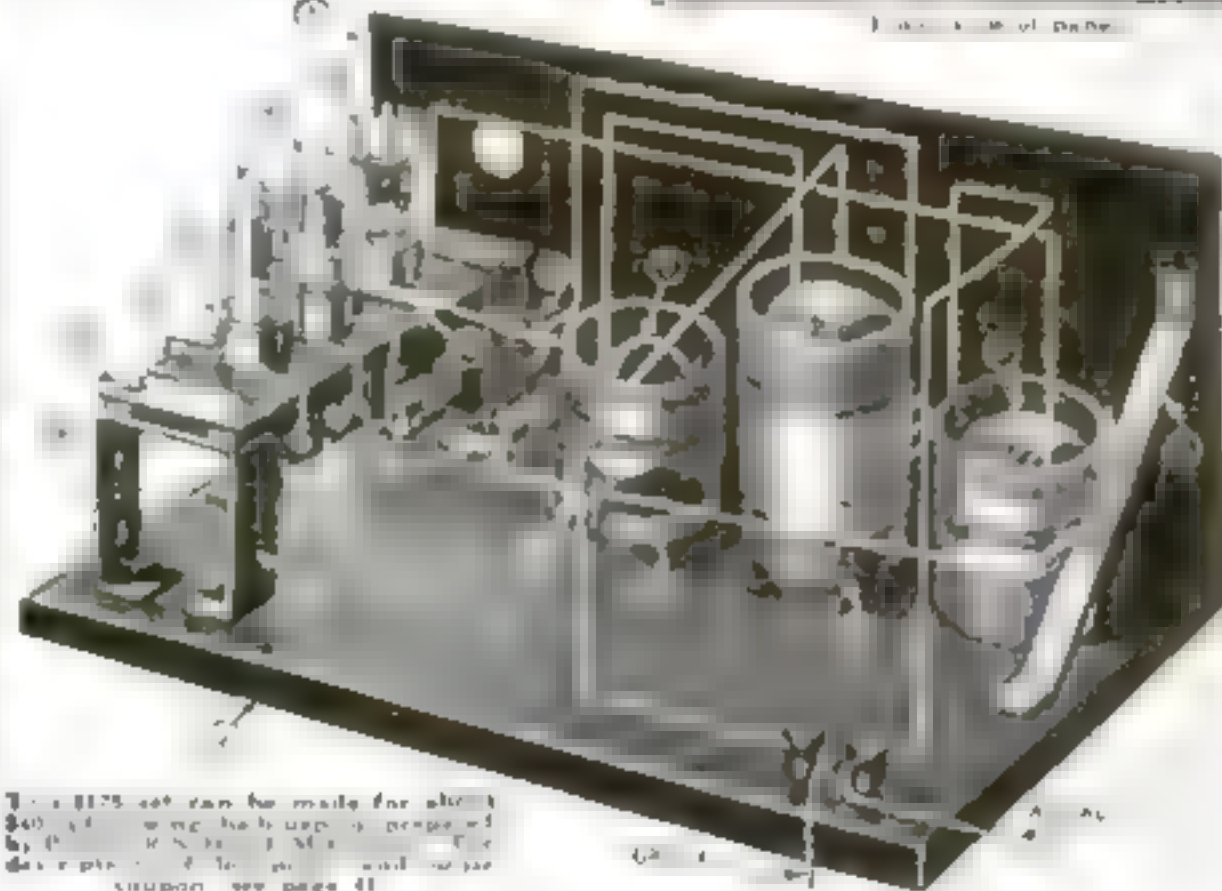
Many men who are not accustomed to working from blueprints or drawings have been successful in making the set, complicated as it is, because of the clearness with which the construction has been described. Each item in the bill of materials is num-

bered and each part in the assembly and detail drawings is marked to correspond. The printed instructions contain the same identifying figures.

These key numbers are shown on the accompanying illustrations of the front and back of the panel, which give clearly the appearance of the complete set.



Front and back of panel



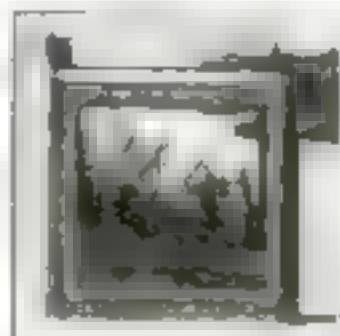
This \$17.50 set can be made for about \$40.00. Working blueprint is prepared by POPULAR SCIENCE MONTHLY. For descriptive list of materials and complete instructions, see page 41.

To Turn a Tobacco Box into an Aquarium

By E. Bade

A SMALL aquarium, which will be found even better than some that can be bought, as well as cheaper, can be made from a large empty tobacco tin.

With a can-opener cut out the sides and top, leaving only a rim $\frac{1}{4}$ in. wide on each side. Then cut pieces of plate or window-glass to fit. Make a paste by mixing a little red lead with common putty and fasten the glass in place. Putty a plate also to the



The complete aquarium

bottom of the tank and cover it with $\frac{1}{4}$ in. of clean sand, which must have been repeatedly washed in a basin until the water was clear. Plant with water plants. It will be found that the tips of some and the roots of other plants should be used.

Before filling the tank with water, place a small piece of paper over the sand so that it will not be stirred up. Let the tank stand near a window for about two

weeks, or until the plants have made roots and have begun to grow. Then a few small fish can be placed in the aquarium.

This makes a balanced aquarium that does not require a change of water.



Hammering down sharp edges

When the aquarium is dry, it can be planted. Place a little top soil on the



Putting in the glass

Your "Best Idea" May Win a \$15 or \$10 Bonus

WHENEVER you make something particularly useful and original in your home workshop, write a letter describing it to the Home Workshop Editor, POPULAR SCIENCE MONTHLY, and send in a photograph or sketch to explain the construction.

Not only does POPULAR SCIENCE MONTHLY pay well for available articles, but it also awards special prizes for the "Best Ideas" published in this department each month. These bonuses for August and September will consist of a first prize of \$15 and a second prize of \$10.

The awards for July are:

FIRST PRIZE, \$15: L. B. Gangawere, Dunbar, Pa. "How to Make a Variable Condenser With Sliding Plates" (see page 88).

SECOND PRIZE, \$10: A. L. Long, Springfield, Ill. "Celebrate the Fourth With a Carbide Cannon" (see page 79).

Cabinet Makes Bread Mixing Easy

WHEN bread is baked at home, the work will be simplified if a cabinet is made for mounting the dough mixer. The mixer rests in a circular hole in the top of the cabinet and is clamped solidly on the

The bread cabinet



top shelf. The pans containing the dough are placed on the shelves of the cabinet during the rising process, and the baked bread and baking utensils are stored in it at other times. It saves many steps and makes bread baking a pleasure.—J. L. D.

Dusting Radiators with Air

IF A vacuum cleaner is available, it is a simple matter to dust radiators thoroughly. Hang an old damp sheet or large dustrag back of the radiator, place the blower attachment on the vacuum cleaner, and blow the dust through the radiator on to the damp cloth at the back. The dust will be forced from every depression in the columns in a fraction of the time required for hand dusting.—J. S. K.

GOODELL-PRATT 1500 GOOD TOOLS



Pocket
Nail-Puller
No. 634
Price, \$1.25

**"It's no job to pull nails
with this nail-puller,"
says Mr. Punch**



A tap with the hammer
sets the piece in the wood
close to the nail.



Then tap the bevel to
close the jaws on the nail.



And pull it like this.
Could anything be simpler?



"It looks like a mighty handy little tool—this Pocket Nail-Puller does. It's small enough to go into a pocket or a nail-pouch, and it's cheap enough so any man can afford to own one. And every carpenter, regular or amateur, can find a lot of work for it.

"You know there's two ways of doing a job like opening a box. One is to knock the top off, breaking a chisel and splitting the cover in the process.

"The other way is to use a Goodell-Pratt Pocket Nail-Puller, and save your tools and your feelings—and maybe save the box so you can use it again."

This Pocket Nail-Puller is a regular one of the Goodell Pratt 1500 Good Tools.

And Mr. Punch says, "An honest tool is like an honest friend; they both stick it out to the end."

Write for free illustrated pocket edition catalog describing the Goodell-Pratt 1500 Good Tools. You'll find much to interest you in it.

GOODELL-PRATT COMPANY, Greenfield, Mass., U. S. A.

Toolsmiths

Finish that Radio Cabinet to Match Your Furniture



Of course you want the cabinet of your radio outfit to match or harmonize with your other furniture. You can quickly and easily accomplish this with Johnson's Artistic Wood Finishes. Our book tells how. Use Coupon

JOHNSON'S WOOD DYE

Johnson's Wood Dye is very easy to apply—it goes on easily and quickly, without a lap or a streak. It penetrates deeply, bringing out the beauty of the grain without raising it—dries in 4 hours and does not rub off or smudge.

Johnson's Wood Dye is made in fourteen beautiful shades, all of which may be easily lightened or darkened—full directions on every label.

Insist upon Johnson's Wood Dye—there's no substitute.

FREE-This Book on Home Beautifying

This book tells how to finish wood in artistic stained and enameled effects. Gives practical suggestions on making your home artistic, cheery and inviting. Tells just what materials to use and how to apply them. Includes color card—gives covering capacities, etc. Use coupon below



A. C. JOHNSON & SON, Dept. PS 1,
RACINE, WIS. (Canadian Factory—Brantford)
Please send me free and postpaid your Instruction
Book on Home Beautifying and Wood Finishing.

The best dealer I please have is

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This Arbor, with Its Quaint Gate and Two Seats, Will Add Charm to Your Garden

NOTHING adds more to the attractiveness of a well-kept garden than an arbor, especially if it has comfortable seats. Such an arbor is the one designed by the Home Workshop Service Department as Blueprint No. 7 in the series of working drawings it is publishing to help readers of **POPULAR SCIENCE MONTHLY** in their work with tools.

This arbor with its arched top, its quaint gate, and its two roomy seats, is a perpetual invitation for one to linger and rest beneath the green canopy of vines. Although of distinctive design and substantial construction, the arbor may be built easily by any one who can read a

working drawing and handle a hammer and saw.

It is 6 ft. across the front and 3 ft. 8 in. deep; the height of the center posts is 7 ft. 6 in., and the width of the gate is 3 ft. These dimensions can be varied to suit individual locations or the taste of the builder.

The adaptability of the arbor to various uses and locations is, in fact, one of its best features. Almost any plain doorway, back or front, will be improved by it. Combined with proper planting, it will lend architectural distinction to an otherwise unattractive entrance.

If the gate is not desired, it may be omitted, although it adds materially to the charm of the arbor. If there is not sufficient depth available for the seats, or if the seats are not needed, they also may be omitted, so that the arbor will consist only of an arched latticework over the gate. In this case it will be necessary to use longer posts and dig post holes for their lower ends.

As designed, the arbor rests on 4 by 4 in. sleepers, which are set in the ground. No post holes, therefore, are necessary. The arbor is like a small house of latticework and is so rigid that it could even be moved from one place to another.

The sleepers have end-lap joints, and the lower ends of the corner posts are cut in such a way that they rest partly on the sleepers and extend down in the inside corner, so that the whole joint is firm and rigid. The slats are simply nailed to the rails, except in the upper end section, where the slats and rails are halved together for the purpose of bracing that portion of the arbor.

The roof bows can be made either by bending 1½ in. by 2 in. pieces in hot water, or by building up the curve from ¾-in. stock. In the latter case, each bow consists of two layers, as it were, one layer of

two pieces and the other of three pieces, all the pieces being segments of the same circle. By cutting these pieces with a keyhole saw and nailing them together so that their joints are staggered, a strong support for the top slats is formed. In the same way, by using three pieces of ¾-in. stock, the ornamental bow

on top of the gate is made.

The gate itself is of the simplest possible construction. The seats are simply two heavy planks supported on cleats and a front rail, and braced by a diagonal support under the center.

For best results cypress or some other good wood for outside work, such as redwood or cedar, should be used. The

arbor can be painted white or finished in any manner considered most appropriate by the maker.

The arbor blueprint contains, besides the assembly drawing and full size details of the top bow and other parts, a complete bill of materials, giving the exact size of each piece. It will be sent to any address on receipt of 25 cents.

Make Your Own Radio Set

ILLUSTRATIONS of the two radio receiving sets, listed below, Blueprints Nos. 6 and 7, will be found on pages 82 and 92.

Coupon for Ordering Blueprints

Home Workshop Service Dept.
Popular Science Monthly
225 West 39th St., New York

GENTLEMEN

Send me the blueprint, or blueprints, I have checked below, for which I enclose _____ cents in stamps or coin

No.	Title	Price	
1	Sewing Table	25c	<input type="checkbox"/>
2	Smoking Cabinet	25c	<input type="checkbox"/>
3	Book Trough End Table	25c	<input type="checkbox"/>
4	30-ft. Monoclane Glider	50c	<input type="checkbox"/>
5	Kitchen Cabinet	25c	<input type="checkbox"/>
6	V. T. Radio Receiving Set	25c	<input type="checkbox"/>
7	Crystal Detector Set	25c	<input type="checkbox"/>
8	Shaving Cabinet	25c	<input type="checkbox"/>
9	Arbor with Gate and Seats	25c	<input type="checkbox"/>

Name

Please print

Street

City and State

THE HOME WORKSHOP

This Artistic Floor Lamp Has
Shade of Art Glass

By George A. Davis

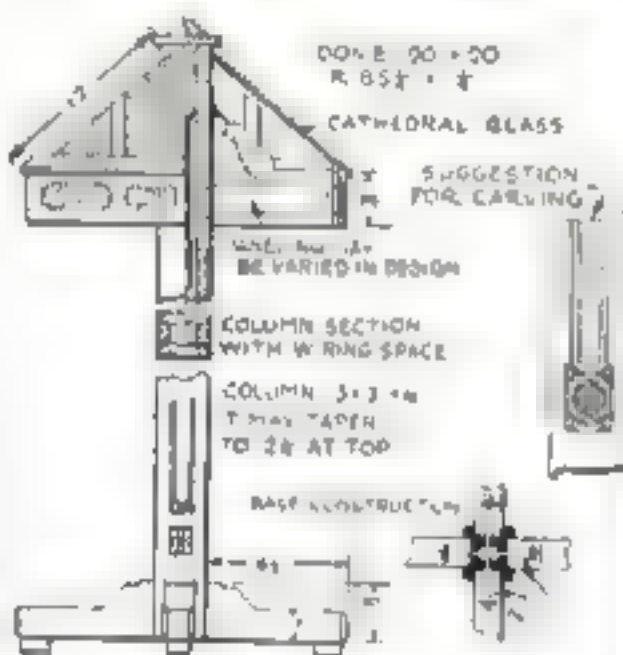
FOR this parlor, piano, or reading lamp, a good cabinet wood should be used, such as bone-dry white or red oak, plain or quarter sawed. The lumber may be obtained from a planing mill cut with just sufficient allowance for finishing at the bench, or the parts may be ripped from the board.

The wood necessary is as follows.

2 pieces	by 3 in. by 6 ft.	for base column
2 pieces	by 3 in. by 6 ft.	for base column
4 pieces	by 3 in. by 10 in.	for base
4 pieces	by 3 in. by 10 in.	for base
1 piece	by 4 in. by 4 in.	for base of canopy
1 piece	by 4 in. by 4 in.	for base of canopy
4 pieces	by 1 in. by 1 in.	for base of canopy
4 pieces	by 1 in. by 1 in.	for base of canopy
4 pieces	by 1 in. by 1 in.	for base of canopy
4 pieces	by 1 in. by 1 in.	for base of canopy
4 pieces	by 1 in. by 1 in.	for base of canopy
4 pieces	by 1 in. by 1 in.	for base of canopy

All the joints are plain butts. They should be nicely fitted and glued and bradded in place. The hip ribs are shaped out of the solid, as shown in the detail.

In cutting the holes for the glass in the four canopy pieces, the best way is to use a



An attractive and colorful lamp for the living-room

hollow-chisel power mortiser; in this way all four pieces can be prepared at one operation, since they can all be fastened together with the layout on the upper piece only. Cut these holes before making the saw kerf for the glass, which may be done with a $\frac{1}{4}$ - or $\frac{3}{16}$ -in. dado head. If a machine is not available, this space for the glass may be formed by using splines at top and bottom and gluing the whole together. All the work, in fact, may be done with ordinary hand tools. Ease off all sharp corners with sandpaper. A common double-cut file will prove useful in smoothing up the inside edges of the glass frames.

The glazing should be done with cathedral glass, which may be purchased from any dealer in art glass. The shade looks well if the upper part is brown, amber and red colored glass and the border green. Pastebord templates are cut to fit and then used as patterns for cutting the glass. Sheet brass of about 26 gage is sheared into $\frac{1}{4}$ -in.-wide strips and formed in a tinner's brake to an angle for the bottom support of the glass in the pyramidal part of the canopy. Make small clips of the same material to hold the glass at the muntins.

The column may be left plain or orna-

(Continued on page 80)

"THE WOOD THAT ALL
IS PRIZE,
THE INVESTOR
SAFELY BUYS."



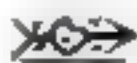
The Water
Cypress
"The Wood Eternal"

When the Baby is a Grown-up

and inherits the beautiful garden, the Cypress arbors and trellises and garden seats will be just about as perfect as they are today. She may, tho, have a few nails tightened up, and probably will want to add some new-style ideas in design—and, of course, the new things will be built of Cypress, "the Wood Eternal". Very likely she will also have the house remodeled or enlarged—with Cypress, "the Wood Eternal". But if it is of Cypress now, she will have practically no *repairing* to do then,—any more than *you* will between now and then. That's economy that really counts. Ask the lumberman to show you the Cypress trademark arrow (shown below) on every board or bundle.

Vol. 28 is the Trellis & Arbor Book. 68 pages. 28 pictures. 23 working plans with specifications. 2 valuable Vine Charts. FREE on request. Write. (Also ask for Vol. 43, a surprise book.)

SOUTHERN CYPRESS MANUFACTURERS' ASSOCIATION



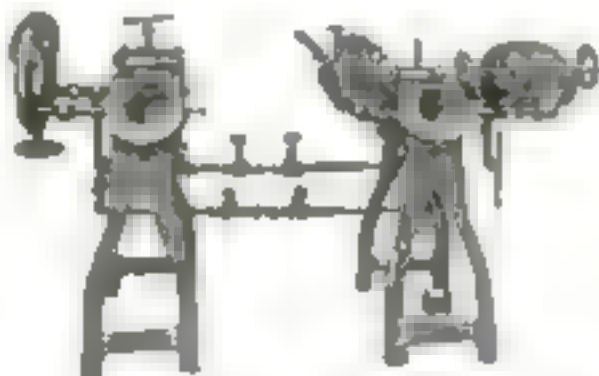
1249 Poydras Building, New Orleans, Louisiana,
or 1249 Graham Building, Jacksonville, Florida



Here's your chance to own a real TIRE REPAIR PLANT AT LOW COST

With prices on Western Adjustable and Non Skid Molds now **reduced to a minimum** — with the mileage guarantee abolished by manufacturers and a contemplated increase in the price of tires — with us giving you complete instructions **free** either in one of our schools near you, or by our home study course — it's **your** opportunity to get in the vulcanizing business and **clean up!**

Prices of the Famous Western Equipment are now even lower than cheap "First Seller" equipment for an outfit repairing all passenger tires, yet the same higher quality of material, workmanship and design, is maintained. They are the same adjustable molds — the same Non-Skid Retreaders with prices in reach of the man with more ambition than money.



Write us at once for particulars and tell us all about your own desires, ambition and conditions in first letter.

WESTERN RUBBER MOLD COMPANY
313 N. Crawford Ave. CHICAGO

Recharge Your Battery at Home

Charges Both A and B Radio Batteries

Don't be without the use of your Radio Receiving Set while your battery is being recharged. The Valley Electric Co. Recharge Your Battery at Home. A single charger for your home use. It will not affect the life of the battery in any way and will give you a quick, efficient charge. It will not overcharge or burn in any way.

It will charge for A and B radio batteries at a single rate and will not affect the life of the battery in any way. It will not overcharge or burn in any way.

VALLEY ELECTRIC COMPANY
Department B ST. LOUIS, MO.

----- Mail the Coupon -----
Valley Electric Co. Dept. B St. Louis, Mo.
Name _____
Address _____
City _____ State _____ Zip _____

\$18.00
F.O.B. St. Louis



Wanted — State Distributors

County and Town Agents for DAY STATE Wrench Sets. No. 21-1 Set (Illustration) takes place of 128 different wrenches — sells for \$7.00 list. Compact, complete with for mechanics, garage and repair men, service stations and car owners. Guaranteed against breakage. Replacement of one wrench for broken one. Set includes one Combination Reversible Ratchet and Split Wrench, one Extension Bar, one Removable Adapter, one Bar when with a complete set of sockets. Sockets with ratchet, a Universal Joint and 8 Allen screws. (See drawing for list of sizes: 1/4", 3/8", 1/2", 5/8", 3/4", 7/8", 1", 1 1/8", 1 1/4", 1 1/2", 1 3/4", 2", 2 1/4", 2 1/2", 2 3/4", 3", 3 1/4", 3 1/2", 3 3/4", 4", 4 1/4", 4 1/2", 4 3/4", 5", 5 1/4", 5 1/2", 5 3/4", 6", 6 1/4", 6 1/2", 6 3/4", 7", 7 1/4", 7 1/2", 7 3/4", 8", 8 1/4", 8 1/2", 8 3/4", 9", 9 1/4", 9 1/2", 9 3/4", 10", 10 1/4", 10 1/2", 10 3/4", 11", 11 1/4", 11 1/2", 11 3/4", 12". (Sockets chrome plated for close work and guaranteed against breakage.)

Demonstration will sell this set. Set is available with owner to buy. Territory open. Agents wanted. Write for proposition.

The Allen Mfg. Co., Hartford, Conn.

THE HOME WORKSHOP

An Artistic Floor Lamp

(Continued from page 85)

mented with simple strapwork carving planned so as to hide the joints through most of the length. To set off the spots enclosed by the carving at the top and bottom, they may be tinted with color before the lamp is varnished. Chip carving may also be used to relieve the severity of the pedestal.

Fill the woodwork with a good paste filler and stain, then shellac and give two coats of good varnish. Rub to a dull finish with pumicestone and linseed oil or apply wax, and rub to a finish.



Details of canopy construction

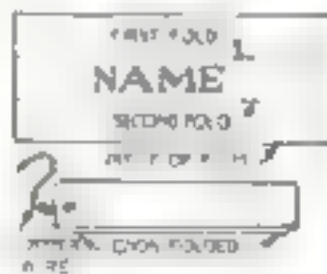
For the wiring it will be necessary to obtain two right-angled sockets with candelabra pull chains, two 1-in. nipples to fit thread in sockets and two wall flanges to suit, all finished in burnished brass; 8 ft. duplex flexible lamp cord, 1 stage plug for connection between lamp and base receptacle; 2 frosted 25-watt lamps. If it is desired to use the lamp as a hall tree also, two brass coat-hooks may be attached to the pedestal.

The canopy may be used without the pedestal as a dome lamp, by suspending it with chains from the ceiling. The necessary chains and hooks can be obtained at any well supplied electrical store.

Old Films Will Make Durable Markers for Shrubs and Trees

IN PLACE of wooden tags, try using old photographic films as permanent markers for young fruit trees, small shrubs and plants. They make neater and more permanent markers.

With black ink write the name of the tree or shrub in the middle of the emulsion side of a small film or a piece of a large film. Then make two folds in the film, so that the name is covered with two thicknesses of film. Fold each end about 1/4 in., press flat, and fold one end a second time. Make



How film is folded

a hole in this end, attach a short length of copper wire, and twist the wire tightly. This will hold the folded film together. The name is read by prying open the folds. —C. C. RICH

Holder Prevents Inkstains

THIS sketch shows a very useful holder for a draftsman's ink-bottle. It is heavy enough to make the spilling of ink practically impossible.

The holder is a 1 1/2-in. standard galvanized pipe cap, which is just large enough to receive the regulation small drawing-ink bottle. —ALEXANDER GRABAU



THE HOME WORKSHOP

How to Make a Rotary Lawn Sprinkler of Pipe Fittings

By Vernon Orr

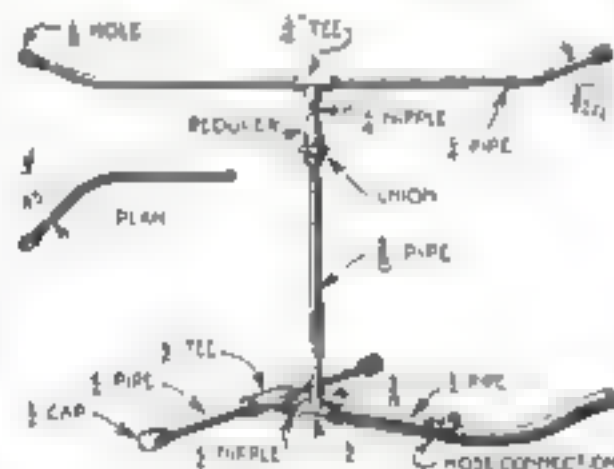
THE rotary lawn sprinkler that is described below is made entirely of pipe fittings that can be obtained at any hardware store. The cost is approximately one half that of a sprinkler of the same size bought at the same store.

To make the sprinkler, the following fittings are necessary:

- 1 nipple, $\frac{1}{2}$ by $\frac{1}{2}$ in.
- 1 nipple, $\frac{1}{2}$ by 1 in.
- 1 tee, $\frac{1}{2}$ in.
- 1 tee, $\frac{1}{2}$ in. with $\frac{1}{4}$ -in. side opening
- 1 piece of $\frac{1}{4}$ -in. pipe, $\frac{1}{4}$ in. long, threaded
- 1 union, $\frac{1}{2}$ in.
- 1 piece of reducing (from $\frac{1}{2}$ to $\frac{1}{4}$ in.)
- 1 cap, $\frac{1}{2}$ in.
- 1 nipple, $\frac{1}{2}$ by $\frac{1}{4}$ in.
- 1 piece of $\frac{1}{4}$ in. pipe, 18 in. long, threaded
- 2 $\frac{1}{4}$ in. nuts
- 1 hose connection, $\frac{1}{2}$ in.

All these fittings and pipe should be galvanized.

Into each end of the $\frac{1}{2}$ -in. tee screw a $\frac{1}{2}$ -in. nipple. On the ends of these nipples put a pipe cap, thus forming a closed pipe about 1 ft. long, with a tee in the center. Into the side opening of this tee screw the 1-in. nipple, then on that nipple put the tee with the $\frac{1}{4}$ -in. side opening. The side



The sprinkler is simple in construction.

opening in this last tee should be perpendicular to the closed pipe. The other $\frac{1}{2}$ -in. nipple should have the connection for the hose soldered into one end. Screw the other end into the remaining $\frac{1}{4}$ -in. opening in the tee. This completes the T-shaped stand for the sprinkler.

The 14-in. piece of $\frac{1}{4}$ -in. pipe is used for the upright and the threaded half of the $\frac{1}{2}$ -in. union is fastened to its upper end. The union is then assembled, the nut being screwed just tightly enough to permit the unthreaded portion of the union to revolve freely without end play. Into the upper portion of the union, screw the reducing bushing, and into that, the $\frac{1}{2}$ by $\frac{1}{4}$ in. nipple. The $\frac{1}{4}$ -in. tee is then screwed on.

Take the two pieces of $\frac{1}{4}$ -in. pipe and bend each to a 45-degree angle about 6 in. from one end. Screw the long end of each pipe into the $\frac{1}{4}$ -in. tee, so that the bends point in opposite directions at about a 22 $\frac{1}{2}$ -degree angle with the horizon. Close the ends of these pipes with the $\frac{1}{4}$ -in. caps and drill a hole with a No. 30 or $\frac{1}{16}$ -in. drill in the center of each cap. With a hacksaw cut a slot in the plane of the 45-degree bends from the hole back along the side about $\frac{1}{2}$ in. This completes the sprinkler.

With 60 lbs. pressure this sprinkler will throw a spray in a 40-ft. circle. Larger or smaller sprinklers can be made by varying the sizes of the pipe and fittings, keeping always to the same general proportions. Before using the sprinkler each time, it is a good thing to oil the union.

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Old methods of brushing leave much of that film intact. The film absorbs stains, so the teeth look discolored. Film is the basis of tartar.

How it ruins teeth

That film holds food substance which ferments and forms acids. It holds the acids in contact with the teeth to cause decay.

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traced to that film, and they are almost universal.

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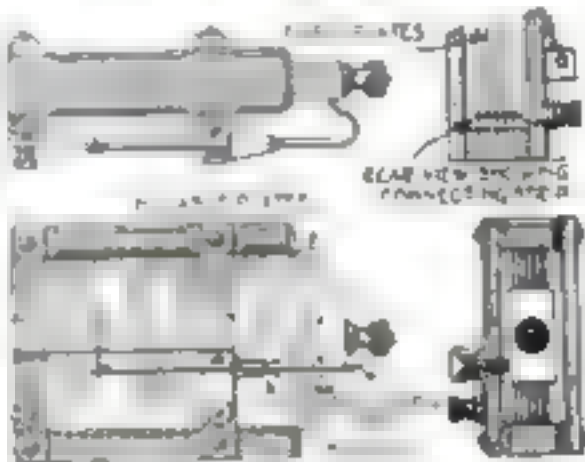
THE HOME WORKSHOP

Construct a Variable Condenser with Sliding Plates

By L. B. Gangware

A VARIABLE condenser with sliding plates may be constructed much more easily than the rotary type. One built by the writer has 5 fixed and 4 sliding plates, the fixed plates being $3\frac{1}{2}$ by 3 in. and the sliding plates $3\frac{1}{2}$ by $2\frac{1}{2}$ by 32 in. It has a capacity of about 00075 mfd. More plates or plates of larger size can be used, if desired.

The top and bottom runways are made of $\frac{1}{4}$ by 1 in. maple, $4\frac{1}{2}$ in. long. After these are planed up in one piece about 1 ft. long, the grooves are laid out in pencil, full length, $1/16$ in. from center to center. A straight edge is clamped along the first line and a broken hacksaw blade worked back and forth until the groove is $1/16$ in. deep. The other eight grooves are cut in



Front, top, and end views of the condenser

like manner. The four verticals are of maple $\frac{1}{4}$ by $\frac{1}{4}$ by $4\frac{1}{2}$ in. long.

The runways are sawed to length and the grooves given a coat of shellac. This should be well brushed in and then scraped out with the back of the hacksaw blade. The piece left over is kept for a "pull" for the sliding plates.

Aluminum Makes Best Condenser

The condenser may be of brass or sheet zinc, but aluminum, if obtainable, is better as it will not tarnish. The writer cut his plates on a photo-print trimmer. The fixed plates are clamped in a vise and a saw cut about $\frac{1}{2}$ in. deep made in one end $\frac{1}{2}$ in. from the edge. This cut is for the connecting strip shown in the detail of the rear end. The verticals are screwed to the bottom runway, the front ones being set back 1 in. from the front so as to be even with the front edge of the fixed plates. The fixed plates are placed in the first, third, fifth, seventh, and ninth grooves, the top runway placed in position, and the verticals squared up and fastened.

The remaining section of the runway stick is cut to a length of $1\frac{1}{2}$ in., and the second, fourth, sixth, and eighth grooves are cut to a depth of $\frac{1}{4}$ in. The loose plates are now slid into their grooves to see that they work freely and when they are partly in, the pull block is shellacked and placed over them. With a small drill make 4 holes through the block and plates and drive in copper wires. These wires make electrical connection between the sliding plates.

The block is fitted with a knob, and drilled for the collecting rod, which is a piece of rather heavy brass or copper wire.

Continued on Page 97



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Popular Science Monthly
225 West 39th Street New York City

How to Make a Variable Condenser

(Continued from page 14)


bent as shown. A small piece of wire is soldered across the ends of the wires that were driven through the block and to the end of the connecting rod.

A brass or copper plate, bent into a bracket and drilled for the collecting rod, is fastened to the front vertical by means of one wood screw and a binding post. Thin brass brushes to bear on the collecting rod are soldered to this bracket. A pointer is soldered to the end of the collecting rod even with the rear end of the condenser.

A strip of aluminum is wedged into the saw cut in the rear end of the fixed plates and brought out under a binding post on the rear vertical. A strip of wood about $\frac{1}{4}$ by $\frac{1}{4}$ in. is mounted on the verticals, just above the collecting rod and the position of the pointer marked on it when the plates are all the way in. The plates are then drawn out so as to clear the fixed plates, and the position of the pointer is again marked. A paper scale, corresponding in length to the distance between these two points, is divided into fifty equal parts and glued to the strip.

Keeping the Tire Care Handy

THE tire gage is considered a necessity around every garage and repair shop, yet it is a small article, easily lost, and, alas, also easily stolen. In fact, after a man is through with it, he is apt to put it into his pocket absent mindedly.




Guest editorial to: 2005

This difficulty is neatly solved by soldering the gage into a small tin can. The can does not interfere with the use of the gage, but it is too bulky to fit easily into the average pocket.—H. F. B.

"Raincoat" for Auto Distributor

MOTORISTS who are troubled with rain or moisture getting to the distributor and causing the engine to miss will appreciate this solution of the problem. The distributor is enclosed in a section of inner tube that is gathered at the top to form a sort of bag with open bottom.

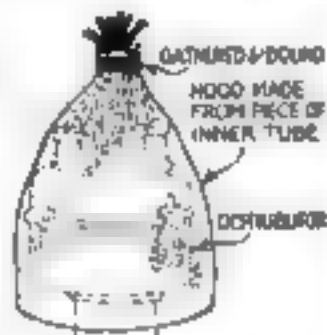


The diagram illustrates the solution: a distributor is shown inside a section of an inner tube. The top of the inner tube is gathered and secured with a cap, while the bottom remains open. Labels with leader lines point to the gathered top, the inner tube material, and the distributor itself.

Labels in diagram:
GATHERED & BOUND
HOOD MADE FROM PIECE OF INNER TUBE
DISTRIBUTOR

Caption below diagram:
Made from inner tube

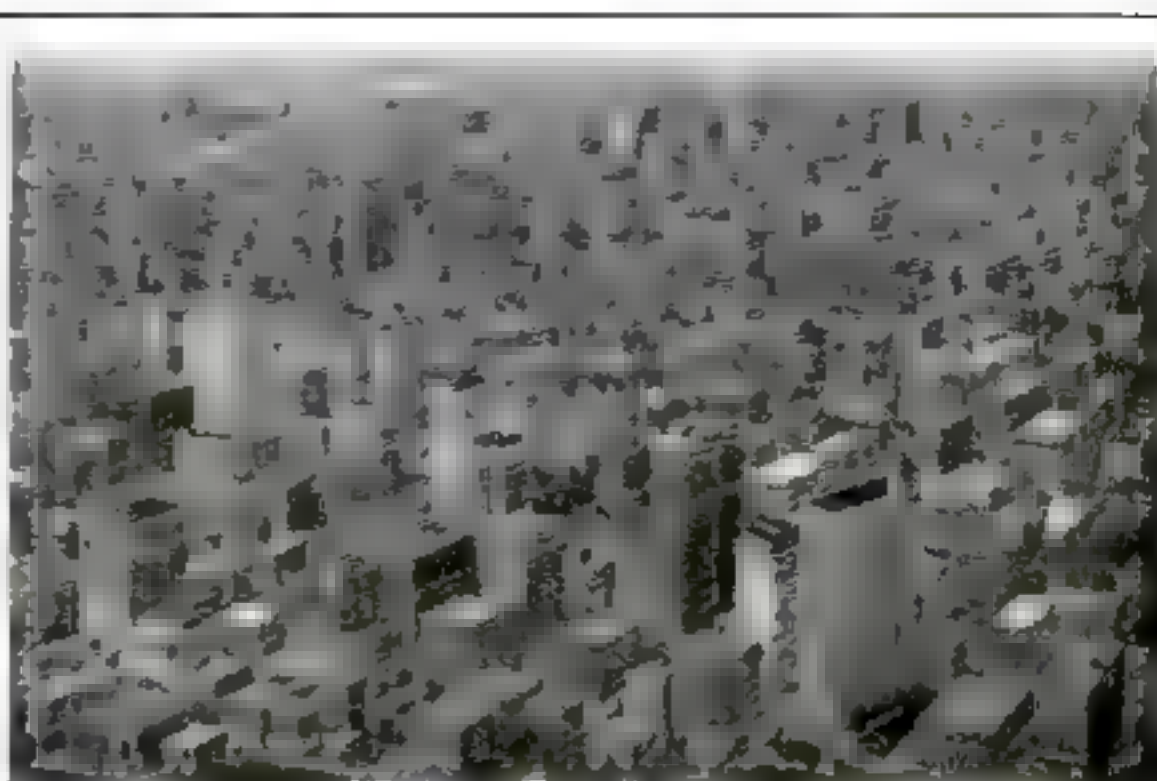
The tube acts as a raincoat and



Made from inner tube

does not interfere with the inspection or the adjustment of the mechanism.—B. J.

Files should not be thrown loosely into a drawer or chest with hammers, wrenches, and other heavy metal tools. It does not take much misuse of a new file to dull it so that it cannot be used to the best advantage. -D E. J.



Only the 50th of the buildings owned by the Rail System are shown in the picture.

A Telephone City

Above is an imaginary city, made by grouping together one-fifth of the buildings owned by the Bell System, and used in telephone service. Picture to yourself a city five times as great and you will have an idea of the amount of real estate owned by the Bell System throughout the country.

If all these buildings were grouped together, they would make a business community with 400 more buildings than the total number of office buildings in New York City, as classified by the Department of Taxes and Assessments.

Next to its investment in modern telephone equipment, the

largest investment of the Bell System is in its 1,600 modern buildings, with a value of \$144,000,000. Ranging in size from twenty-seven stories down to one-story, they are used principally as executive offices, central offices, storehouses and garages. The modern construction of most of the buildings is indicated by the fact that the investment in buildings is now over three times what it was ten years ago.

Every building owned by the Bell System must be so constructed and so situated as to serve with efficiency the telephone public in each locality, and to be a sound investment for future requirements.



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The Radio Handbook

This Loudspeaker Is Built Entirely of Wood

By Walter Lyon

RADIO enthusiasts who are woodworkers can make a loudspeaker that will give good results with a radio receiving set and two stages of audio amplification.

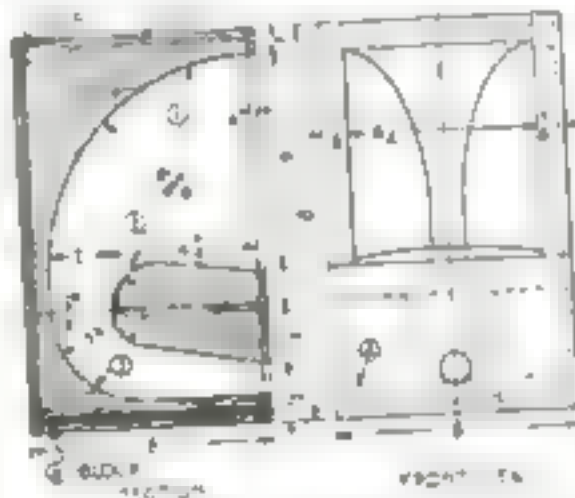
The outside of the loudspeaker may be made of any wood that will match your own wireless cabinet; for best results the interior should be either of white pine or mahogany.

The back of the grooved sound chamber, marked in the illustration, is built up of 1-in. pieces glued together. After the ends have been trimmed square, the 6-in. radius is laid out and cut on a bandsaw or worked out by hand. The curve is then carefully sandpapered to make as perfect a surface as possible.

The next step is to lay out guide lines on top of this block and down the back, so that the angles at which it must be cut intersect



The soundbox with speaker attached

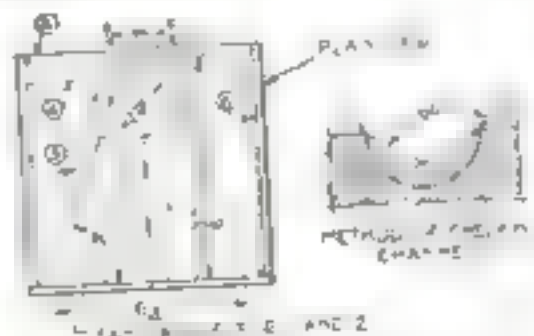


How the tone chamber is constructed

properly with the side pieces. These pieces, which are marked 5, are then attached.

Part 2 is a 1 1/4-in. block, shaped as shown, and cut with the same angles as part 1. It is then glued and nailed between parts 5 and their bottoms.

Part 3 is made of two pieces of 1 1/4-in. stuff, one right and one left-hand, in which a channel is gouged, as shown. The pieces



The top view of the soundbox and a suggestion for the grooves

are then glued together and to the upper section, formed by 1, 2, and 5.

In the same way as part 3, part 4 is made in two halves. Parts 5 which are flanged to hold the telephone receivers, may be made either in the lathe or by hand. Glue a thin piece of felt at the bottom of each

(Continued on page 91)

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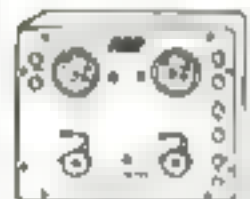
WE here show three ABC Units which form the ideal combination for a receiving set. They may be purchased one at a time if desired, enabling you to add to your station at any time without discarding any equipment.



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This first unit is capable of receiving wireless telephone up to

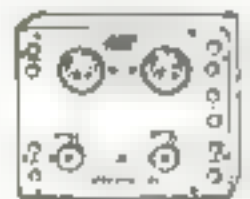
25 miles. The only accessories needed are the "completion package" and 2,000 Ohm head set, making the total price,....\$40.00



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The first two units make a

vacuum tube outfit capable of receiving wireless telephone up to 150 miles. Price, \$37.50; and for both units complete, except storage battery,.....\$94.70



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ABC Standardized Radio



Pictures Show Steps in Making Sensitive Crystal Detector Receiving Set

This Is the Now Famous Radio Set of the Home Workshop Service Department's Blueprint No. 7

DESIGNED by experts for the Home Workshop Service Department, this set is one of the best crystal detectors that has been constructed. It has met most exacting tests even to receiving broadcast on an indoor aerial. Other points of interest about it are:

1. It has few parts and is of simple and practically foolproof construction.

2. It can be built with few tools.

3. It costs complete with telephone and aerial, little more than \$15.

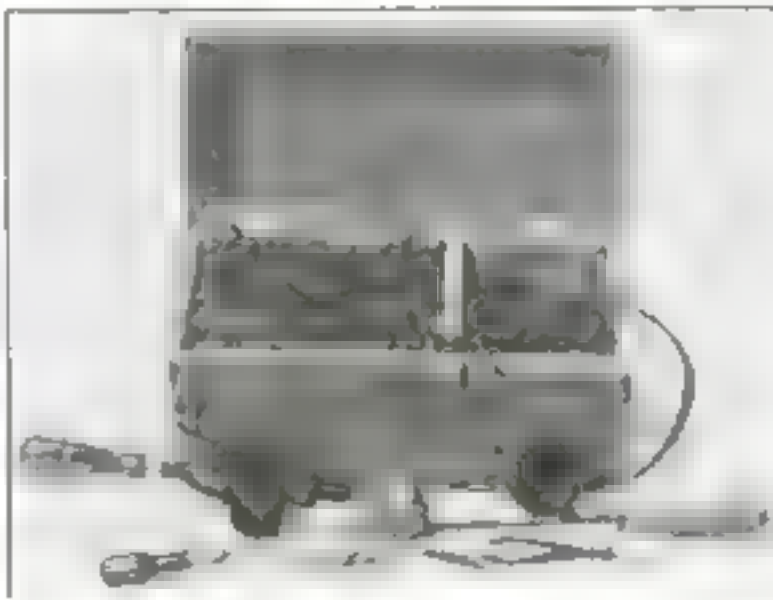
4. It is superior in range and efficiency to the majority of sets costing more than twice as much and is better in many respects than the average \$25 crystal set.

The pictures that follow show the set

in various stages of construction. They are supplementary to the Home Workshop Service Department's Blueprint No. 7 which gives full working drawings, perspective sketches, wiring diagrams, complete bill of materials, and a full-size template of the panel, showing the exact location and size of every hole that has to be drilled.

Even a person who is unfamiliar with the use of working drawings can understand this blueprint. All he has to do is to buy the items in the bill of materials, drill the panel according to the template, make

the condensers, wind the coils, and assemble the parts. The blueprint will be sent to any address upon receipt of 25 cents.



The crystal detector receiving set and the tools used to make all of it except the case. The set is so ingeniously designed that it can be built even without these tools. The soldering iron can be dispensed with; the pliers are not absolutely essential, and any kind of a drill or bit brace may be used. The case can be made with a hammer and saw.

THE first step in making the POPULAR SCIENCE MONTHLY crystal detector radio receiving set is to wind 124 turns of No. 24 single silk-covered wire on a cardboard tube $4\frac{1}{4}$ in. in diameter and $3\frac{1}{2}$ in. long. No wire is wound for a space of about $\frac{1}{2}$ in. at the center where the rotor shaft passes through. The winding is car-



How the rotor and tube are wound. Notice the paths marked by the contact points of the sliders. Small L-shaped brass clips, made from paper fasteners, prevent the turns of wire on the tube from being spread apart by the friction of the sliders.

ried across this space in any convenient way.

The next step is to wind the 4-in. ball rotor with as much wire as it will hold. A ball rotor already turned may be purchased, although if a lathe is available, it is a simple matter to turn one. Wind up one half of the rotor and carry the wire through a small hole into the central opening. Then wind up on the other side, being sure to wind in the same direction, and carry the end through another hole. Splice and solder the ends on the inside.

The panel, which is $5\frac{1}{4}$ by $8\frac{1}{4}$ in., may

be laid out from the blueprint simply by placing it beneath the full size panel layout on the blueprint and making punch marks through to mark the exact center of each hole that must be drilled. Panels of other sizes may, of course, be used, provided they are no smaller, as the set could not be compressed into much smaller space. Three-ply veneer $\frac{3}{16}$ in. thick, if obtainable, will serve as a substitute for a composition panel.

When the panel has been drilled, run a 6-in. length of No. 8 brass rod, threaded throughout its length with 32 threads to the inch, through the tube and ball rotor in such a way that there are 2 or 4 nuts on the rod in the large center hole of the ball rotor. These nuts then can be tightened against the upper and lower internal surfaces of the ball rotor in such a way as to hold it securely. It is advisable to make the hole through the ball rotor a tight fit for the

How the slider unit is assembled. The knob has a threaded 8-32 rod passed right through it. Note the pointer fastened to the knob and the slider arm, which is a piece of No. 30 B & S. spring brass clamped between nuts and locknuts. The extreme end of the arm comes in contact with the winding on the tube. The lead from one slider is taken to the aerial binding post and the other to the ground binding post.

(CONTINUED ON PAGE 97)

THE NEW YORKER

Motor and Generator Bargains

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Bargain No. 1—The efficient $\frac{1}{2}$ h. p., 110 volt cycle, A. C. Motor shown in the cut. Weighs 28 lb. and easily takes care of $\frac{1}{2}$ h. p. peak loads. Just the motor for washing machines, grinders, large vent-lating fans, cream separators, drills, lathes, and other tools. ————— **\$13.50**

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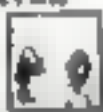


Fig. 1
Fig. 2
Fig. 3
Fig. 4
Fig. 5

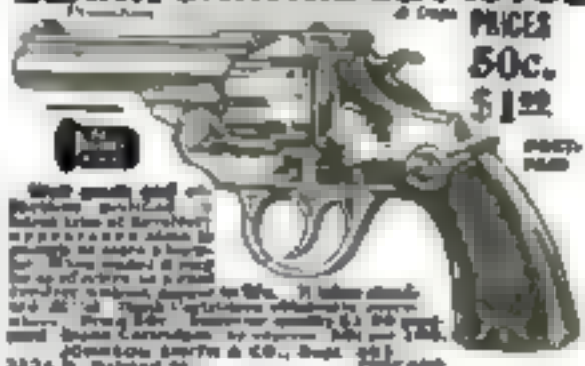


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Making Crystal Detector Set

Continued from page 93

condensers made from tinfoil and waxed paper. One is made of two strips of tinfoil $\frac{1}{4}$ by 2 in., the second of three strips, and the third of five strips. Each strip is insulated from the others by means of waxed paper, and leads from the strips are taken out alternately to the right and left ends by means of fine wire such as may be obtained by untwisting a short length of ordinary lamp cord. When each condenser is finished, it is folded in two places so as to form a square approximately $\frac{1}{2}$ by $\frac{1}{2}$ in. and bound with a piece of tape or



Under side of panel showing tube, rotor, and wiring. Notice at the left one of the slider arms clamped between nuts to the threaded shank of the slider knob. The other slider rod can be seen at the right, partly concealed by the curve of the tube. The small wax paper package at the left contains the stop condenser. The under side of two of the three condenser switch points can be seen just back of the condenser. At the right is another package containing the phone condenser. Notice how the tube is fastened to the panel with a machine screw, nut, a copper burr, and three half burrs used as spacers. Notice also the method of carrying the ends of the winding on each half of the rotor through to the inside and splicing them, and the way the flexible leads are taken from the rotor. Below at the right is a part of the detector rod base and coil-whisker and at the left the aerial and ground binding posts.

gummed paper. Bending them in this way fastens the fine lead wires firmly so that there will be little danger of their pulling out.

The leads from one side of the three condensers are taken to the condenser switch points. The leads from the other side are twisted together and taken to the serial binding post. The condenser switch arm is connected with the ground binding post.

It is necessary also to make a fixed condenser of two pieces of tinfoil 2 in. square. The same general method is followed, even to folding the condenser. One lead is taken to one telephone binding post and the other lead to the other telephone binding post. The condensers are so small they may be suspended by means of their leads, especially if these are enclosed in spaghetti tubing.

The remainder of the wiring is simplicity itself. One slider is connected with the ground binding post and the other is connected with the aerial binding post. One end of the rotor winding is connected with a telephone binding post and the other one with the pivot screws holding the detector rod. The crystal cup is connected with the other telephone binding post.

In order to have the connections from the rotor as flexible as possible, it is well to

Continued on page 95.

THE HOME WORKSHOP

Making the Crystal Detector Set

(Continued from page 94)

make two "pigtails" by twisting together four or five thin wires from a length of lamp cord. If the rotor does not remain fixed, but has a tendency to spring back after being adjusted, arrange two opposing springs of twisted wire at the bottom of the case to grip the rotor rod with sufficient tension to overcome the torque of the rotor leads.

The panel may be fitted into any kind of box that suits the fancy of the maker. The one shown in the blueprint is 15 in. long, 5½ in. wide, and 6 in. high. A lid may be added if desired, 3 in. being a convenient depth for it.

In testing and adjusting the set, it will be noticed immediately that the tuning is very sharp and that a trifling turn of either slider or rotor will tune a station in or out. With certain telephones the fixed telephone condenser does not seem to be necessary, due to the condenser effect produced by the two conductors in the flexible cord leading to the phones.

My Ideal Radio Receiving Set

(Continued from page 78)

unknown guest. And there is no rude awakening, as when the automatic stopper on the phonograph falls and I have to hop to the throttle.

Summed up, my ideal radio station, the station of my dreams, is one that will let me hear anything that is going on between the meridian of Washington and 180 degrees east or west, and between Peary's pole and the one Scott hung a tag on. With a loop of wire no larger than the old-fashioned yarn reel, and a box that I could carry under my arm, I have heard France sending messages to America. Not an inch of wire outside the room where I was listening in. No reason why I should not reach out after Bagdad, Irkutsk, and Tokio.

I want both the simple but efficient galena detector outfit and the most sensitive amplifying receiver, mounted in a case that can be wheeled around as easily as a tea cart and connected in any room in the house with any kind of an aerial that will best serve the purpose of the moment—a high and long one for long-distance work, or a loop that will shut out interference from two directions and give good results on moderate distances.

Then I want one of those little receivers packed in a case as light as my wife's hatbox. With it I want a loop that will lie flat on top of an automobile when not in use and stand up and turn as desired when in use. I want to use it on motor trips and on the train and steamship. I shall need it with me if by any chance I have to spend a season in a hospital or a sanitarium, or a jail!

I have stood on the tops of mountains and looked down at farmers plowing in the valleys, factories spouting their black smoke upward, traffic cops steering lines of cars that look like beetles, busy humanity engaged in scores of occupations. I have whizzed through hundreds of miles of European atmosphere in a giant airplane with the dramatic activities of post-war restoration going on within my sight throughout vast areas. But when I want to get the feeling that the world is mine, to unroll before me, I sit in a big armchair in a darkened room with my ideal radio outfit by my side.



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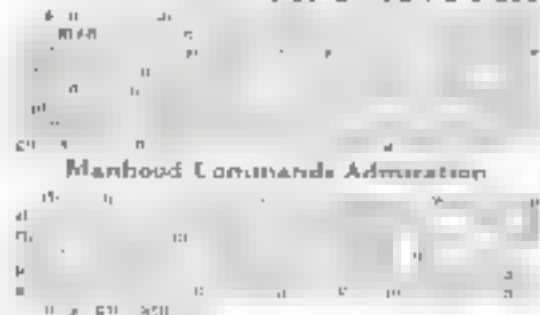
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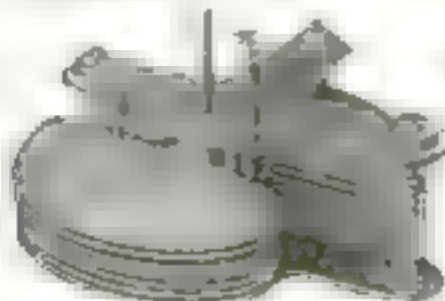
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THE HOME WORK SHOP

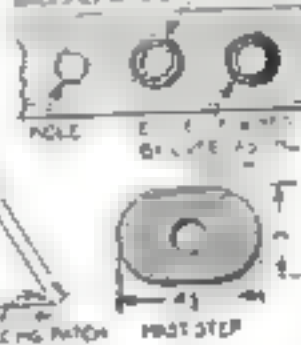
Improve Your Paddling Canoe

The mast thwart is made of 1-in. stock as shown, with a hole in the center for the mast. It is attached to the gunwale of the canoe at each side by means of L-shaped blocks held in place by wing or butterfly nuts. If special blocks cannot be obtained the regulation lanternboard blocks, obtainable at any marine hardware store, and used for attaching lanternboards to the rigging of sailing vessels, may be used to good advantage. The foot of the mast is supported in a mast step of 5/4-in. soft wood, in which

Full diagram, exact detail, and mast step



EXACT DETAIL OF MAST STEP



the mast should be a snug fit. Screw this step to the grating of the canoe or, if no grating is used to a rib taking care that the screws are not long enough to go all the way through.

The leeward thwart has bidge blocks screwed to it at an angle to conform to the curve of the canoe. Make a shallow mortise in the bidge blocks to let in the ends of the leeboard thwart and fasten them together by screwing through the outside of the blocks into the edges of the thwart. Before doing this, however, insert a 2 1/2-in. stove bolt in the center of the bidge block into the thwart mortise, driving it in tightly and letting the end project through the face of the block. This bolt, fitted with a wing nut, will carry the leeboards, which are adjustable at any angle. The leeboard thwart is attached to the gunwale of the canoe by means of blocks in the same way as the mast thwart. The length of the leeward thwart depends upon the width, or beam, of the canoe; the average length is given here.

The leeboards are of 1/4-in. stock cut to the dimensions shown. The edges of the boards are planed down to 1/8 in. thick at the sides so that they will slip through the water more easily.

The sail is laced to the yard and boom by means of common heavy fishline. The yard and boom are attached by driving a wooden plug in the ends of the bamboo, screwing in medium size screweyes, slipping split rings in the screweyes, and coupling yard and boom together by means of an S hook. The boom is kept close to the mast by means of a half jaw, as shown. Any hardware store dealing in boat supplies will have this, or it can be made from a half-round piece of 1 1/2-in. brass, 8 in. long.

The sail is hoisted by a halyard of 3 16-in. cotton rope running through a screweye in top of mast. One end is tied to the yard as shown. No rudder is used and the steering is done by means of the paddle on the lee side of the canoe at the stern. The canoeist sits on the floor of his craft.

THOSE who have oilcans and other containers with small screw tops know how often the tops stick. To give a greater leverage, I soldered a large nail across each lid.—RUTH D. SHULTIS.

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THE HOME WORKSHOP

Easily Made Merry-Go-Round Provides Fun for Kiddies

A FATHER with several children of his own and an interest in his neighbors' children, constructed this unique merry-go-round on a vacant lot. The stump of a tree was utilized for the base. A piece of 1½-in. pipe was set upright in the stump and held



Four children at a time can ride this sturdy whirler

plumb by pouring cement around it. The concrete also formed a substantial coating over the stump.

The framework of the swing was supported by the pipe. Two pieces of 2-in. plank made seats for four children, who either push themselves around with their feet or get another child to turn them. Once in motion, the swing will revolve for a considerable time, merely by its own momentum.—F W SHULTIS.

Shelf under Automobile Cowl

A SHELF under the cowl is handy for the automobile shopper or tourist. Small packages may be laid on this shelf without fear of being stepped on or sat upon. When touring, the road map may be kept at your fingers' tips, and your best



Provides handy place for packages

hat may ride without causing the least ripple of worry as to its safety.

The shelf should be cut a little less than the width of the car body so that it may easily be placed in position and removed. The front edge is notched to fit around the steering column, on which it rests; the back edge rests on bolt heads or a cleat.—W. S. R.

Bicycle Drives Ice-Cream Freezer

IF AN old bicycle frame is lying useless in attic or cellar, or if one can be purchased cheaply, it will pay to rig it up so that it can be used for operating an ice-cream freezer. The frame is blocked up, bolted rigidly, and braced so that a person can sit on it and pedal; and a chain is used to transmit the power to the ice-cream freezer, on which the crank is replaced by a cog wheel.—GEORGE L. DOUGLASS.

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17-A Orange Street Newark, N. J.

THE HOME WORKSHOP

Resilient Bait-Casting Rod

(Continued from page 40)

socket of the tip guide and set it in place with a good quality of waterproof cement, aligning it with the two guides.

Start at *E-F* (Fig. 2), and wrap to *G-H* to strengthen the splice. Finally, put in any decorative windings that may be desired.

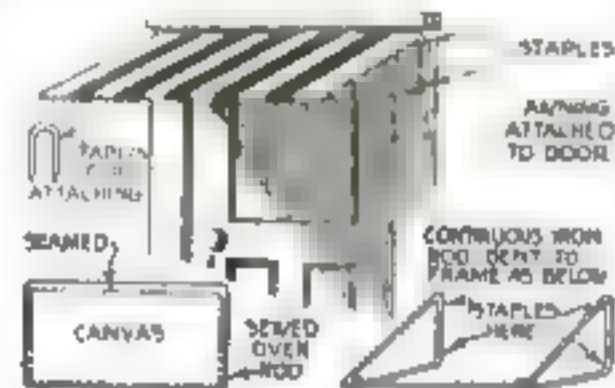
The cane rod handle is scraped and polished and the reel seat is fastened at the back end only. Then soft cord is wrapped and rewrapped until a firm yet resilient handle is built up to the shape desired. The rod is placed in the socket of the handle and pressed firmly home, the guides being alined with the reel seat. A hole is bored through the reel seat, the cane handle and the rod butt and a piece of soft wire is riveted through to hold the parts together.

The ends of the real seat are wrapped with cord and then the rod is ready for varnishing. Use only a brand known to be flexible and thoroughly waterproof. After the first coat becomes tacky, the knots are cut and the free ends wrapped closely around the rod; the varnish then holds them in place. At least three coats should be given; six or seven are better.

In the photograph the reel is shown too far forward to suit most fishermen.

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Useful in many places, this awning costs little to make

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Repairing Clothes-Wringer Rolls

THE rolls of ordinary clothes-wringers usually wear in the center. To repair them two methods may be used with little expense or difficulty.

The first is to shave down the ends of the rolls until the diameter of each is constant throughout its length. This is possible only if the rolls are not badly worn.

The best repair is to build up the rolls with raw rubber, vulcanize them, and trim off the surplus. After removing the rolls, wash them with gasoline and fill the depressions by winding on strips of vulcanizing rubber such as are used for repairing automobile tubes. Wrap strong cord around the fresh rubber, compressing it as tightly as possible and bake the rolls in an oven at 250° for one hour. The rolls are then trimmed with a sharp knife. Finish with fine sandpaper.—D. B. V.



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1. The first step is to identify the problem. This involves understanding the current situation and what needs to be changed.

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It is also possible that the observed differences in the response to the two types of stimuli are due to differences in the underlying neural mechanisms. For example, the response to the high-frequency stimulus may be mediated by a different set of neurons than the response to the low-frequency stimulus. This is a possibility that will be explored in future research.

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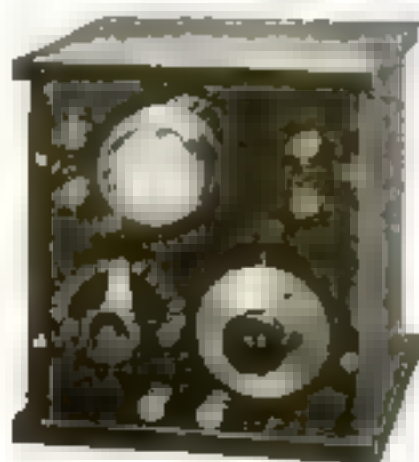
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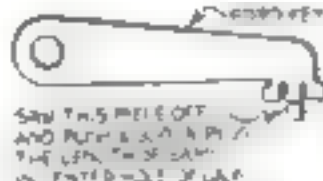
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THE HOME WORKSHOP

Locking a Ford by Modification of the Ignition Key

YOU can rig up a lock that will answer the same purpose as a special Ford ignition switch lock without costing a cent. The trick is simplicity itself, yet it will fool anybody who tries to tamper with the machine.

The working part of the ordinary Ford ignition key consists of one central pin and two side prongs. Saw off the end of the central pin, as shown, and make a little plug of wood just big enough to drive into the central hole of the switch. Cut a piece of this plug the same length as the piece sawed off the key and push it into the hole the central pin of the key enters.



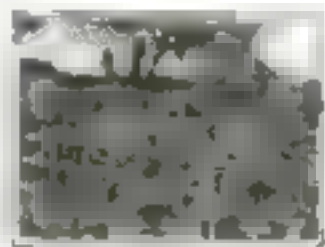
The central prong is sawed off

When Mr. Smart Aleck comes along with his ordinary Ford key and tries to unlock the ignition to have a little joy ride at your expense, he finds that his key will not go into the lock far enough to turn. Your own key, which has been made just enough shorter to go into the lock and turn, will still unlock your own or any Ford not specially protected.—JACK L. BAKER.

Irrigating the Small Garden with Overhead Pipes

A SMALL irrigation system for the garden may be built in such a way that the available water power is made to perform all the labor.

The system consists of an overshot water-wheel connected with a small rotary pump by means of a chain drive. From the pump the water is piped to an overhead system of piping, from which the water is sprayed over the plants. The pipes are so placed that the sprays just meet. The sections of piping can each be shut off.

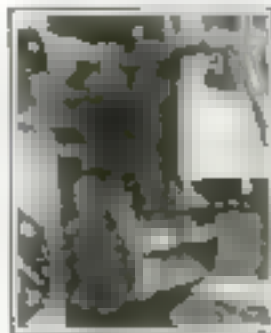


The piping system

The power necessary to drive the wheel in this instance is obtained from water that flows through the spillway around a lock in a canal, but any source of water power may be utilized or wind power can be used in the latter case a tank would have to be provided for the storage of the water.

The ends of the uprights that support the pipes are set in equally spaced holes in the garden. A wooden stake is put in each hole when the piping is taken out in the fall, so that it is easy to replace the uprights in the spring. During the winter the water-wheel, pump and piping are all stored under shelter.

The overhead system of piping does not interfere with cultivating the garden because the piping is spaced well apart and the pipes are not put up until after the garden has been started.—G. E. P.



Water-wheel and pump

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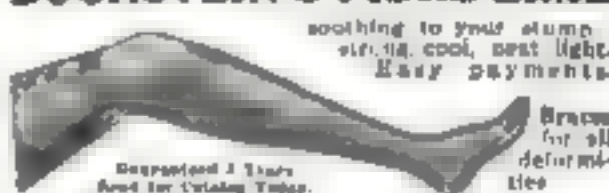
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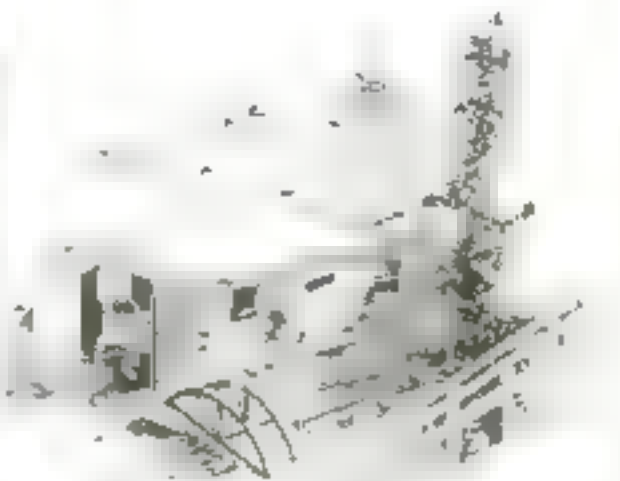
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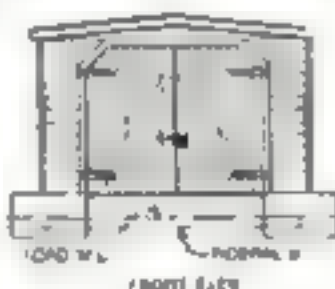
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THE HOME WORKSHOP

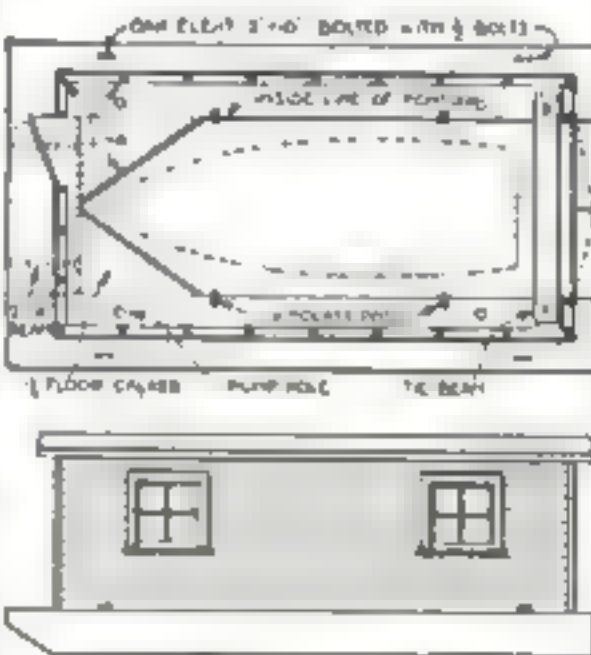
How To Build a Boathouse that Floats on Pontoons



OF COMPARATIVELY inexpensive construction is this floating boathouse. The construction is of the simplest type throughout, from the pontoons to the shed-like roof, so that any one with ordinary skill in handling woodworking tools can confidently undertake its building. The boathouse, as designed, will accommodate a boat 36 ft. long and 10 ft. beam.



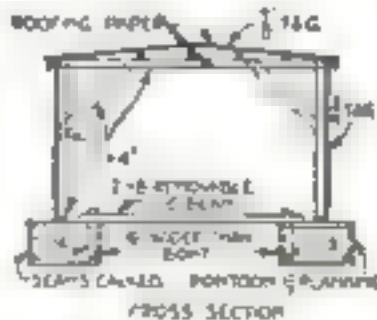
The pontoons are nothing more than watertight boxes. The joints should be beveled.



to form shallow V-shaped seams, open about 1/2 in. on the outside. Fill them with oakum, driving it tightly in with mallet and calking iron. Partitions stiffen the pontoons.

and limber holes are cut to allow any water that may enter to run freely to the pumps. Pad the inside edge of the pontoons to prevent scratching the boat.

The tie beam which prevents the pontoons from strapping out of alignment at the water gate is removed when taking out or putting in the boat. The inside



Front and side views, plan, and cross section of the boathouse

(Continued on page 102)



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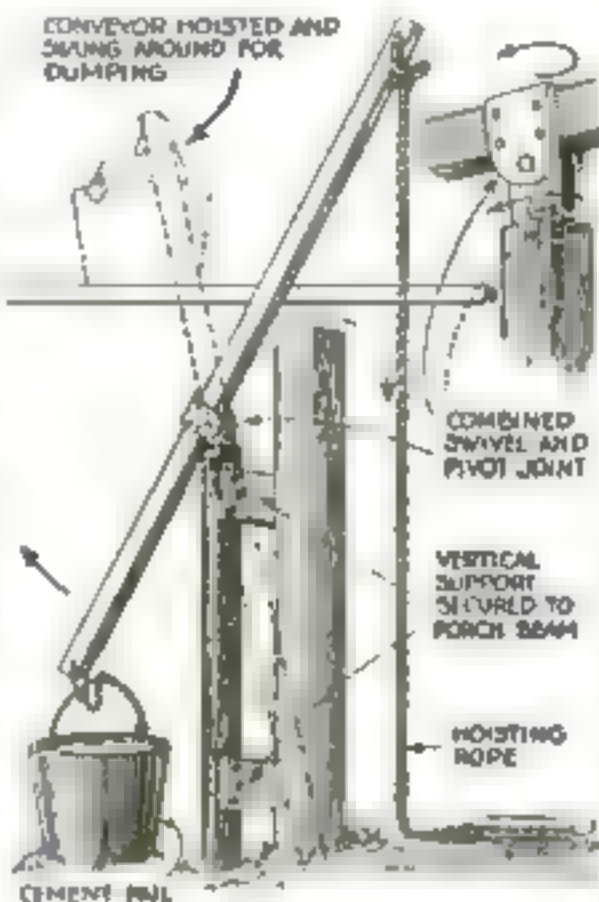
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THE HOME WORKSHOP

Simple Hoist for Delivering Cement to Second Floor

THE hoist rigging here shown is a practical application by a local builder of a lever lift used in placing a cement porch on the second floor of a building. The usual practice is to hoist the cement hand over hand with pulley and rope.

In this instance a vertical support was placed near the porch, bearing a combined swivel and pivot joint connecting



A pull on the rope raises the pail of cement, which then is swung over the platform.

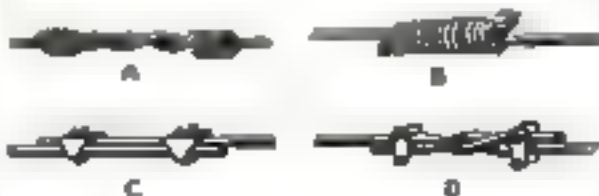
with the lever, which was a "two by four" about 18 ft. long. At one end a large pail was fastened and a rope at the opposite end was used for hoisting.

The pail, when empty, practically balances the beam and lowers automatically for refilling. When the filled pail is hoisted, the lever is turned about on the swivel and swings the pail in on the platform, where it is dumped.—G. A. L.

Splicing Electric Wires

FOUR of the most efficient methods for joining electrical conductors are shown in the accompanying diagram. Figures A and B are twisted joints, the second being more quickly made, but not so strong as the first.

In C the wires are shown held together with wire rope clamps. If the space be-

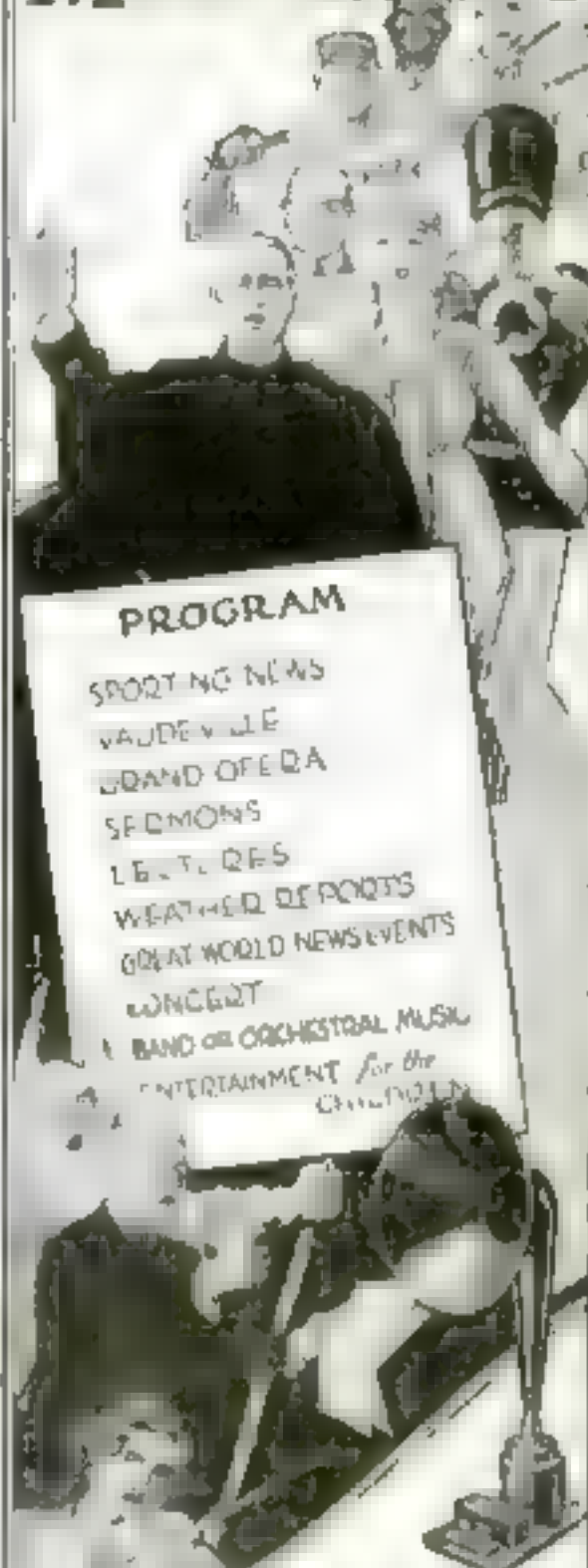


Four joints that are good connections electrically and mechanically

tween the clamps is well soldered, this joint is good for temporary purposes, since the wires may be taken apart quickly.

A more durable joint is shown at D, where the wires are twisted and clamped. All these joints have to be well soldered to be of highest value.—B. H. W.

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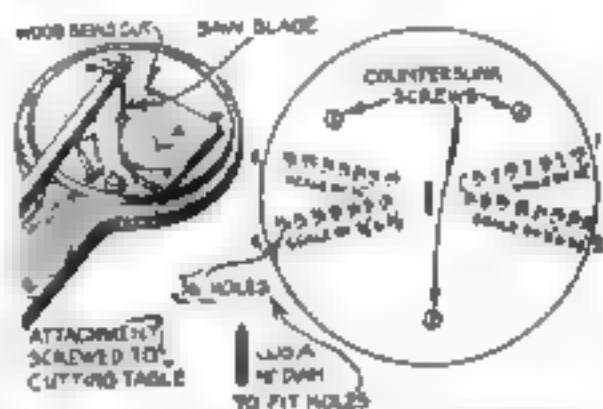
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THE HOME WORKSHOP

Automatic Gage for Sawing Circles on Scroll- or Fret-Saw

A CIRCLE-CUTTING attachment for a scroll- or fret-saw may easily be made. From a $\frac{1}{4}$ -in. board cut a circle of any convenient size and chisel a slot in the center for the saw blade. On four different radial lines lay off scales that will represent certain diameters. On the first, for example, lay off a series of points that will give circles of 1 in., $1\frac{1}{2}$ in., 2 in., $2\frac{1}{2}$ in.,



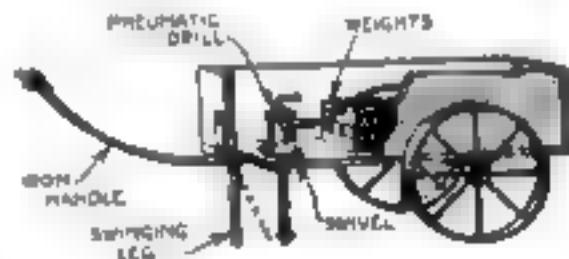
The work pivots on a lug A, which is placed in a hole that gives the correct radius.

etc., when the device is used as shown in the illustration. The actual measurements from the center will be half as much, or $\frac{1}{2}$ in., $\frac{3}{4}$ in., 1 in., $1\frac{1}{4}$ in., etc. Do the same on the second line for circles of $1\frac{1}{4}$, $1\frac{3}{4}$, $2\frac{1}{4}$, $2\frac{3}{4}$ in.; on the third for $1\frac{3}{4}$, $1\frac{5}{4}$, $2\frac{3}{4}$ in., etc.; on the fourth for $1\frac{5}{4}$, $1\frac{3}{4}$, $2\frac{3}{4}$ in., etc. At these points drill $\frac{1}{8}$ -in. holes. Make a sharp-pointed lug to fit them snugly.

The fixture is attached to the saw table with countersunk wood screws. When it is desired to cut a circle, the lug is placed in the proper hole and the piece of wood to be cut is pivoted on it. The wood is then revolved against the saw, the circle being automatically generated.—HUGH CAMP.

Countersinking Rivet Holes in the Boiler Shop

PUNCHED holes in metal fabricated work for boilers, ships, and similar work are usually countersunk to overcome the crystallization that may result. A large boiler shop at Waukegan, Wis., has adopted a small shopmade tool for doing this work. It consists of a pneumatic drill



The drill is mounted on a small truck for ease in handling.

mounted upon a hand truck so that it can swing in the direction of the travel of the truck.

This tool requires little skill or strength. By its use the company has reduced fatigue and accelerated production. The countersinking is done uniformly in shorter time for lower cost.

The truck used is about $3\frac{1}{2}$ ft. long, 2 ft. wide, and 1 ft. high. The pneumatic drill is located at the front of the truck and is carried through the bottom of the truck body on a swivel joint.—K. R.

THE HOME WORKSHOP

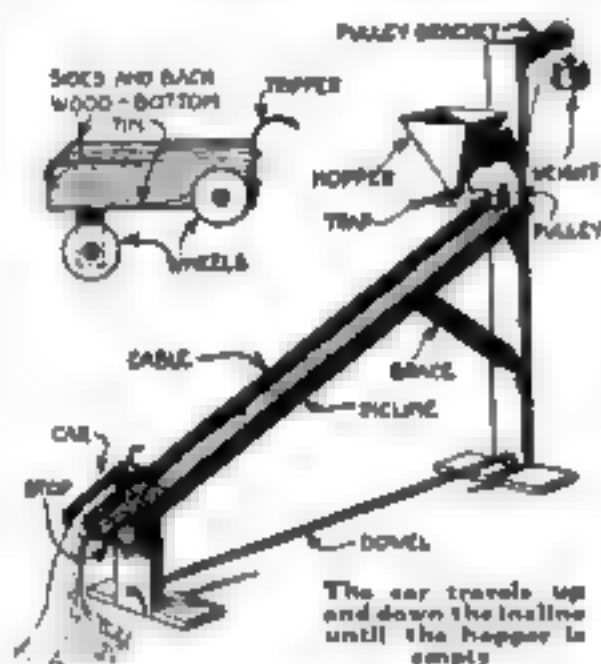
Automatic Toy Sand Dump
Will Amuse the Children

By Charles M. Miller

SMALL children delight to play with sand and it is almost as much fun for mechanically inclined grown-ups to make sand toys of wood and metal. One of these interesting toys is the sand dump illustrated.

First make a trestle incline and a framework to carry the weight cord. The weight travels the same distance as the car on the incline, so the height is dependent on the length of the track. The base must be large enough to prevent the apparatus from tipping over and is further steadied by burying the bottom members a little way in the sand.

The car is built so that the body remains level while on the incline. Wooden buttons



1 in. in diameter make good wheels; tin roofing nail caps are sometimes used. Small wheels may be cast of Babbitt metal or turned on a lathe.

If the bottom of the car is made of wood $1\frac{1}{2}$ by $2\frac{1}{2}$ by 3 in., the rear wheel block can be nailed from the upper side and the sides of tin or light weight galvanized iron can be tacked around the outside. As shown, the sides and end are made of wood and the bottom is of tin. The body can also be made entirely of metal. The wire trip is attached to the rear end of the car, soldered to a metal body or stapled fast to a wooden one.

The base is made with two feet, $\frac{3}{4}$ by 3 by 12 in. One standard is $\frac{3}{4}$ by 3 by 26 in. and the other $\frac{3}{4}$ by 8 by 4 in.; both are let into the foot pieces. A $\frac{1}{2}$ -in. dowel makes a good connecting brace. The incline is $\frac{3}{4}$ in. by 3 in. by 26 in. screwed or nailed to the standards. Pieces $\frac{1}{4}$ in. thick and $\frac{1}{2}$ in. wide are nailed to both sides of the incline; the extra $\frac{1}{4}$ in. is left above the board to guide the car.

The hopper may be made of metal or wood. The pattern for one of metal is shown; the flap should be soldered or riveted. If made of wood, the length of all sides would be 4 in. Two sides will be $4\frac{1}{4}$ in. at the top and $\frac{1}{4}$ in. at the bottom, the other two pieces being 4 in. at the top and $\frac{1}{2}$ in. at the bottom.

The trap prevents the continual flow of sand while the car is down the incline. It is a little scoop hinged to the sides of the hopper. When the car ascends, the wire tripper strikes the under side of the right end of the scoop, pushes it back, and tilts it

(Continued on page 106)

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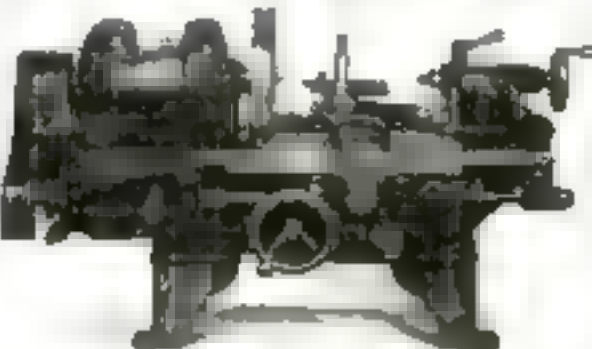
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The A-B-C's of Electricity

(Continued from page 39)

out another. The induction provides a greater range of tuning.

The action of a condenser can be explained without complicated terms, by again drawing upon the water analogy. Suppose we build a water tank with a hinged bottom, the latter so arranged on a simple trigger that when water has been added up to a certain definite volume, the bottom drops out suddenly, discharging the water in an avalanche. To complete the picture, it must be assumed that the trigger device automatically returns the tank bottom, ready for the next discharge. We have, then, the case of a water tank fed by numberless small pipes, the pipes discharging their loads into the tank until the liquid has reached a certain level. At that point the tank bottom collapses and discharges the entire contents. Almost immediately the bottom is returned and the tank is filling again.

The Hard-Working Condenser

The condenser, as used in radio circuits, functions in a similar manner. The little electric waves come through the aerial, pass into the condenser, where they pile up, until the condenser has all it can hold. Then, like the water tank, it discharges all the stored up electrical energy instantly. Of course, it should be realized that this complete action takes place hundreds of thousands of times a second, but each time the action is identical.

Before proceeding further, an understanding of the meaning of the term "wave length" and of the manner in which radio waves are formed is essential.

If two persons had at their disposal a pond of perfectly still water, of almost any length, they could arrange mechanical devices that would produce waves at one side and direct them at the other, just as radio waves sent out from a transmitting station are detected by a receiving set. One method of carrying out this experiment would be to arrange a beam so that it could be dipped into the water at the will of the operator. The beam would cause water waves of different sizes to move in circles away from the sending station. At the opposite side of the pond a light float, connected with a recording pencil, would move up and down as the waves reached it, thus leaving a record of their shape and relative intensity. A beam of given size, moving the same distance each time, would produce waves of a certain size. The length of these waves would be measured by the distance between the tops of two adjacent waves.

How Radio Waves Are Formed

In radiotelephony, the waves of electricity have the same general shape as water waves, but with greater lengths. They are produced by the proper combination of inductance and capacity in the sending apparatus. Inductance, as a rule, decreases the wave length. Capacity, connected with inductance coils, gives the effect of increasing the wave length. Many amateurs do not consider this fact in adjusting their transmitting sets, and as a result they fail to keep within the amateur wave length regulations of the government. They have the notion that an increase in capacity will increase the energy radiated by the aerial, forgetting that in



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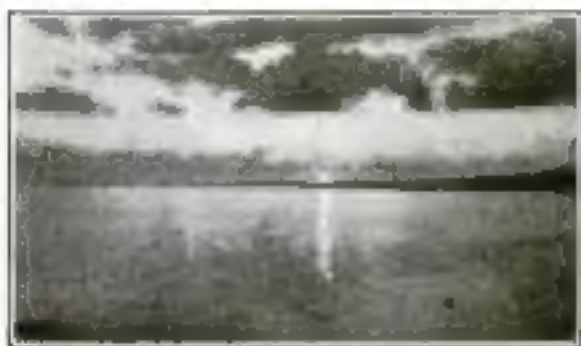
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How to Take Unusual Pictures with a Cheap Camera

By J. F. Yocum

MANY amateur photographers think that they cannot take unusual and striking pictures unless they have a costly camera with a fine lens and shutter. That is a mistake, because the ordinary camera will register in black and white on the sensitive films of today as much and more than the eye can see. It is mainly a matter of making the proper exposure.

The accompanying photographs were taken with a postcard-size folding camera



A snap and a time exposure on one film achieved this effect

that has no special attachments of any kind. They show that good pictures can be obtained even under adverse conditions.

In taking the sunset view, the camera was placed on the tripod about fifteen minutes before sunset, and pointed by means of the finder directly at the sun. The distance was set at 100 ft., time 1/100th second, diaphragm F-16. Just as the sun touched the horizon, the bulb was pressed. That gave sufficient exposure for recording the sun and its reflection on the water. The camera, film, and diaphragm were left in the same position until the sun went down and then a time exposure of 5 seconds was given, registering the clouds, sun, and hills on the same film. The above view is looking toward San Pedro from the pier at Long Beach, Calif.

To make the portrait of myself, I set the camera carefully at the distance measured to the chair where I was to sit, and set the bulb for time, with the diaphragm closed to the smallest opening. The bulb was pressed, starting a slow exposure; I quickly seated myself and remained still for four minutes; then I got up and stopped the exposure by pressing the bulb again. The picture was taken in a darkened room with only one small north window open.



A self portrait taken without attachments

The picture of lightning was taken on a dark night in northern Illinois. The camera was set pointing ahead of a thunderstorm that was passing some distance away. The diaphragm was given its largest opening and the bulb set at time and pressed. This can be done on a dark night and the film left for a period of five minutes before it is materially harmed by the exposure. If,

(Continued on page 112)



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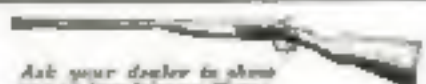
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THE HOME WORKSHOP

How to Take Unusual Pictures

(Continued from page 111)

however, some small flashes of lightning occur, a new section of film will have to be turned up. When the big flash comes, close the shutter immediately.

Nineteen seconds were counted from the time the flash was seen until the thunder was heard. As sound travels 1100 feet a second, the flash proved to have been nearly four miles away.

In one lightning picture I was puzzled by a sort of ball of light, as if a flash had been snarled up. Enlargement of the spot



This lightning flash timed itself

showed that it was really the projection of a crooked streak coming from a distance to join the main streak, which was closer to the camera.

To obtain the photograph of the pacing race, the camera was set to point at a certain pole and when the leading pacer's nose came in line with the pole, the camera was snapped at 1/100th second and F-5. It will be noticed that this view brings out the well known fact that there is an instant in a pacer's gait when all four feet are off the



The leading pacer has four feet off the ground

ground. The leading pacer is in that position in perfect form; the second horse has two down and two up, also in perfect form, but at another phase of a pacer's gait.

Good pictures can be taken from the window of a fast train or the observation platform, but do not attempt to take a picture looking forward because cinders or flying sand are apt to ruin your camera's lens.

When grinding, a pan of water on the cross slide and under the wheel will catch sparks and dust.—J. T.

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